OMEGA CHEMICAL SUPERFUND SITE
WHITTIER, CALIFORNIA

FIELD SAMPLING PLAN

WESTON®
MANAGERS DESIGNERS/CONSULTANTS

OMEGA CHEMICAL SUPERFUND SITE
WHITTIER, CALIFORNIA

FIELD SAMPLING PLAN

Contract No.: DACA45-98-D-0004
Task Order No.: 0009

July 2001

Prepared for:

U.S. Environmental Protection Agency
Region IX

Prepared by:

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July 27, 2001

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Subject: Final Field Sampling Plan and Quality Assurance Project Plan for Omega Chemical OU 02 Groundwater Remedial Investigation/Feasibility Study.

Dear Ms. Rivland-Har:

Enclosed please find two copies of the subject reports. A set of these reports has also been forwarded to Mr. Peter Husby and Mr. John Hartley.

Please call me at (818) 382-1800, extension 1803 if you have any questions.

Sincerely,

ROY F. WESTON, INC.

Carol A. Yuge

Carol A. Yuge
Principal Project Manager

CC: P. Husby (USEPA)
J. Hartley (USCOE)

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SECTION 1

INTRODUCTION AND SITE BACKGROUND

1.1 INTRODUCTION

This Field Sampling Plan (FSP) is a field guide for conducting field sampling in support of the remedial investigation/feasibility study (RI/FS) of groundwater at Operable Unit Number 2 (OU-02) of the Omega Chemical Superfund Site (Omega) site located in Whittier, Los Angeles County, California. This FSP, along with the Quality Assurance Project Plan (QAPP) (WESTON, 2001a) and project-specific Health and Safety Plan (HASP) (WESTON, 2001b), comprise the Sampling and Analysis Plan (SAP) for this project.

The following tasks are described in this FSP:

- Site Preparation/Presampling Activities
- Push Probe Groundwater Investigations
- Monitoring Well Installation
- Groundwater Sampling
- Management Plan for Transportation and Disposal of Investigation-Derived Waste (IDW).

Quality assurance/quality control (QA/QC) and analytical requirements associated with the project are identified in the QAPP which is being submitted concurrently. Minimum health and safety requirements, procedures, and protocols are set forth in the site-specific HASP, which was submitted under separate cover to EPA in May, 2001. Specifications for management of Investigation Derived Waste (IDW) are described in Section 2.7 of this FSP.

Common field procedures (especially regarding sample management) are described in Section 2 of this FSP. Section 3 describes the methodology for each of the RI tasks to be completed under the current authorization. Appendix A contains Standard Operating Procedures (SOPs) for field tasks.

1.2 PURPOSE

The purpose of this groundwater investigation is to collect lithologic and groundwater quality data down-gradient of the former Omega site (OU-01), determine the nature and extent of groundwater contamination at the site; determine the potential for impact to public water supply wells, and attempt to identify potential sources other than Omega for contaminants previously detected in the groundwater. These objectives will be accomplished during two phases of investigation. The initial phase will consist of collecting groundwater grab samples from up to 100 direct-push borings and analyzing the samples for volatile organic compounds (VOCs, primarily halogenated) using an on-site laboratory. These results will be evaluated and used to assess plume extent, assess potential sources, and establish locations for installation of approximately 20 monitoring wells. These wells will be installed at several depths ranging from approximately 70 to 170 feet below ground surface (bgs) (to be decided based on site stratigraphy) and will be used to monitor plume margins, secondary source areas, if identified, and "hot spots" with elevated contaminant concentrations. The wells will be sampled during routine groundwater monitoring and also used to collect water level data for determination of groundwater flow direction in support of the RI.

1.3 SITE BACKGROUND

The Omega Chemical Facility is located at 12504 and 12512 East Whittier Boulevard in Whittier, Los Angeles County, California. Whittier is a city with a population of about 85,000 located 12 miles southeast of the city of Los Angeles. The city of Santa Fe Springs is located southwest of the facility and the community of Los Nietos is included within Santa Fe Springs to the south. Unincorporated County of Los Angeles land is present to the northwest as well as farther west beyond Santa Fe Springs. A site location map and site features map are presented in Figures 1-1 and 1-2, respectively.

The Omega property is a 40,000 square foot parcel that is zoned for industrial use. The area around the property is a mixed neighborhood with residential, commercial and industrial areas. The site is bordered by Whittier Boulevard to the east, Skateland (roller skating rink) to the south, Terra-Pave (grading and paving contractor) and Putnam Street to the west-southwest, and Medlin & Son (formerly Calaire – which was an air conditioning contractor) property to the north. There are residential areas to the east beyond Whittier Boulevard; to the south or southeast across Washington Boulevard and Santa Fe Springs Road; and within one-half mile to the west of the facility. There is a large hospital, the Presbyterian Inter-Community Hospital, two blocks west of the facility.

1.3.1 Past Activities

The facility operated as a RCRA solvent and refrigerant recycling and treatment facility, handling primarily chlorinated hydrocarbons and chlorofluorocarbons from approximately 1976 to 1991. Drums and bulk loads of waste solvents and chemicals from various industrial activities were processed to form commercial products. Chemical, thermal and physical treatment processes were believed to have been used to recycle the waste materials. Wastes generated from these treatment and recycling activities included still bottoms, aqueous fractions, and non-recoverable solvents.

1.3.2 Previous Site Investigations

A series of soil gas, soil and groundwater investigations have been performed at the site by a variety of consultants beginning in1985. The EPA issued Unilateral Administrative Order (UAO) 95-15 to the Settling Defendants on May 9, 1995 and amended the same in September 1995. Among other things, the UAO required the removal of various containers of materials and decommissioning of certain equipment at the Omega Property. A removal action was completed in September 1995; over 3,000 drums, containers, and debris were removed from the site, and both structural and process equipment surfaces were decontaminated. Subsequent to this, EPA entered into a Consent Decree with a number of potentially responsible parties (OPOG – Omega Chemical Site PRP Organized Group) on February 28, 2001.

The Statement of Work of the Consent Decree requires OPOG to do the following:

1) Design and implement a groundwater containment and mass removal treatment system in the Phase 1a Area.
2) Implement a vadose zone RI/FS for contaminant releases on, at or emanating from the Omega Property.

3) Install three sentinel groundwater monitoring wells and sample quarterly for one year at two or three locations downgradient of the Phase 1a Area and upgradient of water supply well 30R3.

The PRPs began Phase II field investigation activities in November 1995. A chronology of recent field investigation activities is provided below.

November 1995

- Shallow soil gas survey
- Shallow soil sampling and analysis.
- Storm water sampling and analysis.
- Installation of monitoring well OW-1 to 80 feet below ground surface
- Collection of groundwater grab samples using push probe techniques at four on-site locations within approximately 15 feet of the water table (piezometers H-1 through H-4 [H-4 screened approximately 57 to 72 feet bgs]), and at another on-site location (H-4A, screened from 70 to 85 feet bgs. Due to refusal encountered above groundwater in one off-site location (H-5), no groundwater sample was collected there.
- Soil vapor extraction test.
- Results of these studies are provided in a series of reports and memos by England & Hargis (1996a, 1996b and 1996d). VOCs including tetrachloroethene (PCE), trichloroethene (TCE), 1,1-dichloroethene (1,1-DCE), 1,1,1-trichloroethane (1,1,1-TCA), methylene chloride and Freons were detected in groundwater beneath the site. The highest concentrations of PCE and Freon 113 detected were 81,000 ug/L and 6,300 ug/L, respectively. The highest concentrations of methylene chloride and TCE detected were 15,000 ug/L and 3,400 ug/L, respectively.

July 1996

- A second round of push probe groundwater sampling was conducted at eight off-site locations (H-6 through H-13). Boring H-13 was established approximately 1,500 feet southwest (downgradient) of the site. These eight samples were intended to further characterize and define the downgradient extent of the VOC groundwater plume in the immediate vicinity of the site. Total depths of these borings ranged from approximately 72 to 122 feet bgs.

- The results are reported in C_2REM (1997). PCE and Freons were detected in all of the samples. Concentrations of PCE were detected ranging from 9.5 to 86,000 ug/L. Concentrations of Freon 113 range from less than 700 to 7,500 ug/L. Concentrations of methylene chloride detected range from not detectable at 10 ug/L to 110,000 ug/L.

March 1997

- A third round of off-site push probe groundwater sampling was conducted at four off-site locations (H-14 through H-17). Boring H-17 was completed approximately one mile southwest of the Omega site.
- The results are reported in C_2REM (1997). Concentrations of PCE were detected ranging from 71 to 580 ug/L. Concentrations of Freon 113 range from below the detection limit of 2 ug/L to 57 ug/L.
- Borings H-16 and H-17, which are located within approximately 250 feet of each other (north-south), display differing PCE concentrations. The PCE concentration at H-16 is 71 ug/L, while at H-17 it is 580 ug/L. The approximate sample depth for H-16 is 40 to 50 feet bgs, while for H-17 the sample depth is 30 to 40 feet.

June/July 1999

- Installation of one deep on-site (OW-1b) and two shallow (OW-2 and OW-3) off-site monitoring wells. OW-1b is screened between 110 to 120 bgs and located adjacent to OW-1. OW-2 and OW-3 were screened about 60 to 80 feet bgs, and are located along Putnam Street, just west and southwest of the site, respectively.
- Collection of six soil gas samples at 10-feet intervals from OW-1b to a depth of 60 feet bgs. The soil gas samples were analyzed for analysis of VOCs.
- Collection of 12 soil samples from the OW-1b, OW-2 and OW-3 borings for analysis of VOCs.
- Collection of groundwater samples from the one existing and three new wells for VOCs.
- A series of step-drawdown tests were conducted on OW-2. Estimates of hydraulic conductivity range from 0.8 to 1.6 feet/day.

- The results of these investigations are presented in CDM 1999. PCE, TCE; 1,1,1-TCA; 1,1-DCE; chloroform; and Freon 113 and Freon 11 were detected in the soil gas samples. PCE concentrations ranged from 150,000 ppb to 6,100,000 ppb. Concentrations of these chemicals generally increased with depth with the highest concentrations of VOCs generally in the sample at top of the water table. PCE and Freon were also detected in the soil samples. PCE concentrations in the samples from OW-1b, the boring with the highest soil concentrations, ranged from 4.7 ug/Kg to 3,300 ug/kg. As noted for the soil gas, the highest VOC soil concentrations were detected in the soil samples in the vicinity of the water table. PCE, TCE, 1,1,1-TCA, 1,1-DCE, Freon 113 and Freon 11 were detected in groundwater samples from all four wells. The highest VOC groundwater concentrations were detected in the shallow on-site well OW-1. No evidence of free-phase hydrocarbons was detected.

Spring 2001

- Installation of three additional off-site, down-gradient groundwater monitoring wells (OW-4A, OW-4B, and OW-6) in accordance with CDM's Sampling and Analysis Plan (2001). Wells OW-4A and –6 are water table wells whereas OW-4B is screened at greater depth, and co-located with OW-4A. One other proposed well, OW-5, which is to be sited as a water table well still farther down-gradient, has not yet been installed.
- Collection of groundwater samples for VOCs.
- The three wells OW-4A, -4B, and –6 have been sampled once since their installation (CDM memorandum, July 13, 2001). Results indicate PCE concentrations of 1,000 ug/L and 28 ug/L, respectively, at wells OW-4A and –6. Only 1.2 ug/L of PCE was detected in deep well OW-4B.

In summary, the groundwater investigations conducted to date show that maximum contaminant levels (MCLs) for one or more constituents including PCE are exceeded in six monitoring wells and in push probe groundwater samples collected up to nearly one mile downgradient of the site. Historical groundwater sample locations and selected historical results are presented in Figures 1-3 and 1-4. Estimated concentration plume maps for PCE and Freons interpreted by England and Hargis (1996) for the immediate vicinity of the Omega site are adapted herein as Figures 1-5 and 1-6. The approximate sampling (or screen interval) depths for the previous push probe explorations are summarized in Table 1.

CDM (1999) argues that the nature and extent of VOC contamination detected downgradient of the site suggest that several commingled VOC plumes are present in groundwater. However, no direct evidence was provided to support this hypothesis.

All of the data collected from this field investigation will assist EPA in selecting a remedy to eliminate, reduce, or control risks to human health and the environment. The goal is to develop sufficient data necessary to support the selection of an approach for site remediation and then to use this data that results in a well-supported Record of Decision.

1.3.3 Regional Hydrogeological Setting

The site is located in the Central Basin of the Coastal Plain of Los Angeles County (CDWR 1961). The Coastal Plain is bounded on the west and south by the Pacific Ocean and by mountainous uplifts on the north, east and southeast. The Coastal Plain is underlain by an extensive groundwater basin in Los Angeles and Orange Counties.

The known water-bearing sediments in the Whittier area extend to a minimum depth of 1,000 feet below the ground surface. The identified geologic units consist of Recent alluvium, the upper Pleistocene Lakewood Formation and the lower Pleistocene San Pedro Formation. Figure 1-7 shows a generalized stratigraphic column of water bearing sediments in the Whittier area.

Based on the geologic map provided in CDWR (1961) the uppermost unit in the vicinity of Omega site consists of the so-called "Bellflower aquiclude." The Bellflower aquiclude comprises all the fine-grained sediments that extend from the ground surface down to the first aquifer. The Bellflower aquiclude consists primarily of clay and sandy clay to silt, and ranges from 20 to more than 40 feet in thickness in the area. CDWR (1961) includes the Bellflower aquiclude in both the recent alluvium and the upper part of the Lakewood Formation. In the Whittier area, the Bellflower aquiclude is assigned entirely to the Lakewood Formation. Water-bearing zones locally occurring within the Bellflower aquiclude are referred to collectively and informally as the Semiperched aquifer.

The Lakewood Formation consists of non-marine deposits of Late Pleistocene age and attains a maximum thickness of 70 feet. The Gage aquifer is the major water-bearing member and comprises the basal lithologic unit of the Lakewood Formation. It consists of about 30 feet of sand with some interbedded clay. Based on previous investigation at the Omega site, the Gage aquifer appears to be absent beneath the site proper. A sand interval observed in explorations a short distance southwest of the site is believed to correlate with the Gage aquifer (England and Hargis, 1996). The Gage aquifer appears to extend eastward beyond the projected location of the site on the published, generalized cross-section of the area (CDWR Bulletin 104, Section B-B'), which is aligned east-west approximately 2.5 miles south of the site. However, the explorations conducted thus far suggest the Gage is present west of the Omega site; but pinches out or disappears towards the east. The Gage aquifer does not appear to be an important source of drinking water in the Whittier area, because elevated TDS concentrations were observed during sampling, and it appears that none of the local water supply wells have been completed in this aquifer.

Underlying the Lakewood Formation are primarily marine sand and gravels with interbedded clay, assigned to the San Pedro Formation. The San Pedro Formation reaches a maximum thickness of 850 feet and extends to a depth of about 920 feet. The San Pedro Formation unconformably underlies the Lakewood Formation. This unit has been folded somewhat sharply and is exposed in the nearby Puente Hills. The San Pedro Formation has been subdivided into five named aquifers separated by clay members. A fine-grained layer is also typically present at the top of the sequence, although in localized areas, the uppermost San Pedro Formation aquifer may be merged with the overlying aquifer, and one or more of the five aquifers may also be merged, as depicted on Section B-B' from Bulletin 104. This suggests that the Gage sand unit could directly overlie and be in hydraulic connection with San Pedro Formation aquifers in the vicinity of the Omega site. Subsurface explorations conducted near the site to date, however, have identified clays underlying the suspected Gage-equivalent sand unit.

The five aquifers defined within the San Pedro Formation include, from top to bottom, the Hollydale, the Jefferson, the Lynwood, the Silverado, and the Sunnyside. The upper two aquifers are less extensive and appear to be absent in the immediate vicinity of the Omega site.

The San Pedro aquifers consist of varying amounts of sand and gravel with some interbedded clay. The thickness of the aquifers increase with depth. The shallow Hollydale aquifer ranges from 10 to 25 feet whereas the deepest Sunnyside aquifer ranges from 200 to 300 feet. The base of the Sunnyside aquifer reaches a maximum depth of about 1000 feet below the ground surface.

The Pliocene and Miocene sediments below the San Pedro Formation generally contain saline water in the area, but locally contain freshwater.

1.3.4 Site Geology/Hydrogeology

The geology of the Omega site has been explored with borings and Cone Penetration Test (CPT) explorations. The location of historical borings in the vicinity of the site is shown in Figure 1-3. A geologic cross-section beneath the site is shown in Figure 1-8. The site is underlain by low permeability silty and clayey soils to a depth of at least 120 feet. No significant water producing sand units have been found directly beneath the site in any of the explorations. A sand unit, which may correlate with the Gage aquifer, has been encountered downgradient of the site. The estimated eastern extent of the sand unit based on the investigations near the site is shown on Figure 1-9.

The hydraulic conductivity of the upper silty unit was estimated from step-drawdown tests conducted in OW2 and a slug test at well OW1. The hydraulic conductivity in this area was found to range from 0.6 to 1.6 feet per day.

Groundwater occurs at approximately 70 feet bgs. Locally, groundwater flow appears to be generally to the southwest. CDM (1999) reported a local direction of groundwater flow towards the southwest with a hydraulic gradient of 0.009 ft/ft. Total dissolved solids (TDS) concentrations of greater than 3,000 mg/L were reported in shallowest groundwater samples by CDM (1999).

Based on review of England-Hargis (1996), there are 6 water supply wells within 1.5 miles of the site (Figure 1-2). The nearest well (02S/11W30-R3, AKA Santa Fe Springs Well No. 1) is located 1.3 miles to the west -southwest of the former Omega facility. The well is screened at 200 to 288 feet bgs and 300 to 900 feet bgs. TCE (0.7 ug/L) and chloroform (1.3 ug/l) were detected in water samples from the well in October 1994. The Los Nietos water supply well (02S/11W30-Q5)is located about 1.5 miles southwest of the site. This well is screened from 152 to 370 feet bgs. PCE and TCE were detected at unspecified concentrations in 1986-90. The remaining wells are no longer operating, are used for irrigation, or no data was available. One of the tasks for this project is to collect available data on the status of monitoring and water supply wells in the vicinity of the site.

SECTION 2

COMMON PROCEDURES

The procedures to be followed during the investigation are designed to ensure that the resulting data are representative of conditions in the field, capable of supporting sound remedial decisions, and are legally defensible. Samples will be assigned a sample designator as outlined in Section 2.1, field and sampling equipment will be decontaminated before and during use as indicated in Section 2.2, samples will be handled as provided in Section 2.3, field activities will be documented as per Section 2.4, field quality assurance/quality control (QA/QC) samples will be collected as per section 2.5, IDW will be handled as per Section 2.6, and changes to the work plan will be made in accordance with Section 2.7. Task specific procedures are discussed in Section 3.

2.1 SAMPLE DESIGNATION

For tracking and data management, samples will be assigned a unique 14-character alphanumeric identifier according to the method described in this section. The numbering system will be used to identify each sample collected; to facilitate tracking, retrieval, and data processing; and to maintain relationships between samples.

Each sample number consists of three components separated by a dash (-) that correspond to media code/sampling phase, station identification, and sample type/depth, as described below:

- *Media Code/Sampling Round (first component)*—A five-character alphanumeric designation, consisting of the two-character media code:

  GW - Groundwater
  SO - Soil

  ...and a three-character designation to indicate the sample round quarter (1 through 4) and year (last two digits):

301 -3rd quarter, 2001.

For example, GW301 would indicate a groundwater sample collected during the third quarter of 2001. This designation scheme prevents duplication of sample numbers in subsequent sampling events at fixed stations. One-time samples such as groundwater grab samples and soil samples will also be tracked in this manner.

- *Sample Station (second component)*—A five character alphanumeric designation to identify the geographic sample location or station number according to the project area sampling station map:

MW020 - Monitoring well number 20
PP100 - Push probe boring number 100

- *Sample Type/Depth (third)*—A four character numeric designation, consisting of a leading number to indicate the QA/QC sample type:

0### - Field sample (No QA/QC)
1### - Field duplicate
2### - VOC trip blank
3### - Ambient field blank
4### - Equipment rinsate blank
5### - Split sample with another party;

...and a three-character field following to indicate sample depth in feet:

#001 - 1 foot
#050 - 50 feet
#125 - 125 feet

Sample depth determinations will be made to the nearest foot. The three-character field is a component of the four-character numeric designation. Some typical sample numbers are as follows:

- GW301-MW009-0108 — A groundwater sample collected during a third quarter sampling round in 2001 from monitoring well 009, from a depth of 108 feet below ground surface (bgs), measured as the approximate depth to the midpoint of the well screen.

- GW301-MW009-1108 — A duplicate of the sample described immediately above.

- GW301-PP095-0088 — The groundwater sample collected during the third quarter of 2001, from direct push boring 095, at a depth of 88 feet bgs, measured as the approximate depth to the midpoint of the exposed portion of the boring sidewall adjacent to the Hydro Punch Screen or temporary PVC well screen.

VOC trip blanks (2###), ambient field blanks (3###), and equipment rinsate blanks (4###) present a unique situation as they are not associated with a sampling depth, nor are they necessarily the same matrix for which they are being collected. Instead of depth, the last three characters of the fourth component will be sequentially numbered, as in the examples below:

- GW301-MW008-4001—The first equipment rinsate blank collected during sampling in the third quarter of 2001, collected from equipment used to collect the associated groundwater field sample from monitoring well 8.

- GW301-PP005-2004—The fourth VOC trip blank collected during the investigation, included in the sample cooler containing the assigned VOC field sample collected from direct push boring 005. If multiple field samples are included in a sample cooler, the field sample number associated with the trip blank will be selected at random from the field samples in that cooler.

Note that the blanks associated with these sampling stations are assigned a matrix "GW," even though the blank sample is not comprised of actual sample matrix, because it is intended to evaluate whether the samples are being contaminated by factors related to collection, packaging, and transport of the field groundwater samples.

Under the sample designation method described above, the identifier will be unique (i.e., no two samples will have the same number), and informative (i.e., will show sampling round, method of collection, location, sample type, and depth interval). This designation scheme will facilitate data management and tracking during the evaluation and reduction of RI/FS data.

Samples to be analyzed by laboratories that are part of the EPA Contract Laboratory Program (CLP) will also be assigned and labeled with unique sample identification numbers provided by the EPA. Both sample identifications will be included on the CLP chains-of-custody. WESTON will also maintain a cross-reference on field sampling forms between the proposed sample designation scheme numbers and EPA sample numbers.

Sample designation procedures are further discussed below for individual sampling tasks using relevant examples.

2.2 SAMPLING EQUIPMENT DECONTAMINATION

Drilling and sampling equipment will be decontaminated between sampling points to prevent contamination of clean areas, to prevent cross-contamination between sampling locations, and to assist in maintaining the health and safety of field personnel and the general public.

Dedicated or disposable sampling equipment will be used where feasible to reduce the possibility of sample cross-contamination. The majority of the sampling equipment will have to be decontaminated in the field. Equipment that cannot be effectively decontaminated will be disposed of after each sampling event. The monitoring wells will be equipped with dedicated pumps and discharge pipe/tubing.

The following is a partial list of sampling equipment that will be decontaminated in the field:

- Stainless steel bailers
- Split-spoon samplers
- Continuous soil core barrels

Decontamination will consist of the following four steps:

1. Alconox™ low phosphate detergent and tap water solution wash
2. Tap water rinse
3. A solvent rinse (pesticide grade isopropanol) if high organics concentrations are anticipated.
4. Distilled, carbon-free water rinse
5. Air dry, away from potential sources of contamination (e.g., splashes, airborne particulates, vehicle exhaust)
6. Because metals are not considered to be contaminants of concern (nor suspected to occur at elevated concentrations), a nitric acid solution rinse will not be employed.

Heavy drilling and push probe equipment, such as augers, will be decontaminated using a high-pressure washer (> 1,200 pounds per square inch) or a steam-cleaner (> 180°F). Decontamination of push probe extension rod will be by wet-wiping using clean towels and Alconox™ solution. Cone sensors and push probe sampling tools will be decontaminated in accordance with the process listed above. Because the vehicles on which the drilling or advancement apparatus are mounted will be operated on city streets and not within areas of gross surface contamination, decontamination of the rig vehicles will not be necessary. Decontamination liquids generated will be collected and disposed of per Section 2.7.

2.3 SAMPLE HANDLING

Sample containers will be labeled with the required information on the label. Each label will include the information in Section 2.4.3 written in indelible ink. Labels will be affixed to the sample containers in a manner so as to prevent separation of the label from the container. The sample will be preserved as required (Section 2.4.1). Sample chain-of-custody procedures outlined in Section 2.4.3 will be observed. Samples will be packaged in a manner that will prevent damage and prepared for shipping (Section 2.4.4).

2.3.1 Sample Preservation and Holding Times

Samples will be preserved as described in specific analytical procedures presented in the U.S. EPA Contract Laboratory Program (CLP) statements of work for organic and inorganic analyses (EPA, 1990a,b) or in EPA methods for analysis of solid wastes (EPA, 1986), or water and wastes (EPA, 1983). Sample preservation and holding time requirements are presented in the Sample Analyses Summary, Table 2.

Samples for analyses requiring preservation will be checked for proper pH using pH paper. The preserved bottle (or first bottle for samples with multiple bottles) will be filled with the sample matrix. For bottles not used for VOC analysis, a small amount of preserved sample will be poured into a small disposable container, and checked with the pH paper. If the pH is within the specified range for the analysis, the sample bottle will be topped off if necessary and closed. For bottles to be used in VOC analysis, the first vial is considered sacrificial and will be tested with pH paper directly and discarded, including when the pH is within the specified range. Any other preserved bottles for each analysis will be filled and closed.

If the pH is outside the specified range for the analysis, the initial sample bottle will be discarded and a new bottle with additional preservative will be filled and checked in the above manner until the pH is within range. The preservative in any additional bottles for that analysis will have been adjusted to the same quantity of preservative necessary for the first.

Samples to be analyzed in the on-site FASP laboratory will not be preserved, as all of those samples will be analyzed well within the specified hold time of seven days for unpreserved VOC samples.

2.3.2 Sample Containers

All sample containers obtained for this sampling will be precleaned following the requirements in EPA guidance documents (EPA, 1989).

Container requirements vary according to analyte, sample matrix, and hazard classification. It is anticipated that all samples collected for the project will be low hazard. The type and number of sample containers required are specified in Table 3.

2.3.3 Sample Custody

Custody procedures will be performed to provide a documented, legally defensible record that can be used to follow the possession and handling of a sample from collection through analysis. A sample is in custody if it meets at least one of the following conditions:

- Is in someone's physical possession or view
- Is secured to prevent tampering
- Is secured in an area restricted to authorized personnel

Sample control and chain-of-custody procedures in the field and during shipment will be performed in accordance with the procedures in the CLP Sampler's Guide (EPA, 1990c). Except as noted below, sample containers will be labeled prior to the time of sampling with the following information:

- Sample number
- Sampling date
- Time
- Analyses required
- Preservative, if any
- Initials of person sampling

When sample spillage during collection may obscure the sample labels, the label will be affixed immediately after sample collection but prior to collection of another sample. When labels do not adhere well due to splashes or condensate, they will be secured with a small strip of tape, taking care not to obscure label information. A chain-of-custody record will be completed for each container (cooler) of samples at the end of each day of sampling for samples to be shipped.

Samples to be analyzed in the on-site FASP laboratory will each be hand-delivered to the lab after collection by the individual that collected the sample. The pertinent information will be completed for each sample as it is delivered, on a chain-of-custody maintained in the on-site laboratory. Custody seals will be placed on each sample bottle and on the coolers or packages containing the samples so that the bottles and packages cannot be opened without breaking the custody seals. Coolers for samples hand-delivered to the on-site lab will not be sealed with custody tape unless out of sampler's immediate custody. The completed chain-of-custody forms will be delivered to the recipient laboratory with the respective samples. For samples shipped to the analytical laboratory, the chain-of-custody will be placed in a resealable plastic bag taped to the inside of the cooler lid. For samples to be hand delivered to a fixed laboratory, the chain-of-custody will be placed in the resealable plastic bag affixed to the outside of the cooler lid, so that integrity of the package can be maintained while allowing signature for intermediate custody transfer.

The QA officer or designate at each laboratory will verify that the sample container and package custody seals are unbroken. The accompanying chain-of-custody records will be properly signed upon receipt of the samples by the laboratory QA officer or designate. Any questions or observations concerning sample integrity will be noted. The QA officer will also ensure that a sample-tracking record is maintained that will follow each sample through all stages of laboratory processing and storage.

2.3.4 Field Custody Procedures

The following guidance will be used to ensure proper control of samples while in the field:

- As few people as possible will handle samples.
- Coolers or boxes containing cleaned bottles will be sealed with a custody tape seal during transport to the field or while in storage before use. Sample bottles from unsealed coolers or boxes, or bottles that appear to have been tampered with, will not be used.
- The sample collector will be responsible for the care and custody of collected samples until they are transferred to another person or dispatched properly under chain-of-custody rules.

- The sample collector will record sample data in the field logbook and on a sample record field form.
- The site team leader will determine whether proper custody procedures were followed during the fieldwork and will decide if additional replacement samples are required.
- All coolers shipped will include a temperature blank consisting of an unpreserved bottle filled with potable water.
- Packaging, marking, labeling, and shipping of samples will comply with all regulations promulgated by the U.S. Department of Transportation (DOT) in the Code of Federal Regulations, 49 CFR 171 – 177 and International Air Transport Assoication (IATA) regulations.

When transferring custody (i.e., releasing samples to a shipping agent), the following will apply:

- The coolers in which the samples are packed will be sealed and accompanied by two copies of the chain-of-custody records. When transferring samples, the individuals relinquishing and receiving them must sign, date, and note the time on the chain-of-custody record. This record will document sample custody transfer.
- Samples will be dispatched to the laboratory for analysis with separate chain-of-custody records accompanying each container shipped, specific to the samples in that container. Shipping containers will be sealed with custody seals for shipment to the laboratory. The chain-of-custody records will be signed by the relinquishing individual, and the method of shipment, name of courier, air bill number, and other pertinent information will be entered on the chain-of-custody record before placement in the shipping container.
- All shipments will be accompanied by chain-of-custody records identifying their contents. The original custody records kept in a sealed Ziplock bag and taped inside the lid of the cooler will accompany the shipment. The other copies will be distributed appropriately to the site team leader and site manager.
- If sent by common carrier, a bill of lading will be used. Freight bills and bills of lading will be retained as part of the permanent documentation.

2.3.5 Shipping Requirements

Shipping and handling of samples will be done in a manner that protects both the sample integrity and shipment handlers from the possible hazardous nature of samples. All samples will be shipped by express air service or, for a local laboratory, delivered by a courier or field personnel. Packaging, marking, labeling, and shipping of samples will comply with all applicable regulations promulgated by the U.S. Department of Transportation (DOT) in the Code of Federal Regulations (49 CFR 171-177) or International Air Transport Association (IATA) regulations, as applicable. Detailed requirements are discussed in the CLP Sampler's Guide (EPA, 1990c).

For samples that are to be shipped, the following step-by-step procedure will be followed to ensure that all applicable requirements for classifying, packing, marking, labeling, and documenting samples will be met.

1. Obtain current DOT or IATA regulations as applicable.
2. Determine the correct technical name or composition of substances that may be in the samples. Check to see if the substance is forbidden on aircraft. Section 1 of the IATA regulations for dangerous goods contains a list of substances that cannot be transported by air.
3. Ensure that all samples are transported by cargo aircraft or land transport in accordance with applicable DOT or IATA regulations.
4. Refer to the DOT or IATA references, as applicable, to select the appropriate shipping container and packing material.
5. Prepare the consignment according to relevant requirements. Utilize an appropriate freight bill for the shipment (e.g., a bill tailored to shipment of dangerous goods, if applicable).
6. Ensure that all appropriate markings are printed on the packages and that labels are attached. Attach a separate label to the package indicating the recipient's address.
7. Make any appropriate advance arrangements with the carrier.
8. Complete the cargo air bill and sign the appropriate declarations for transporting dangerous goods, if applicable.

9. Deliver the shipment to the local office of the freight carrier.
10. Ensure that all chain-of-custody procedures are observed. The copy of the bill-of-lading form will be retained as further evidence of the custody transfer.

In addition, all samples that are suspected to be of medium or high hazard will be packed in metal paint cans as described in the CLP Sampler's Guide (EPA, 1990c). It is anticipated that all samples will be low level hazard. However, if high level hazard samples are shipped, the laboratory will be notified.

2.3.6 Laboratory Coordination

Sample shipments and document control will be performed as part of sample management. Development of data packages and data validation will be performed by EPA. WESTON will perform data reduction and prepare data summaries after receiving data from the off-site laboratories through EPA. All scheduling for analytical work, and data dispersal will be arranged in close conjunction with the laboratory and the EPA coordinator. Sample containers will be ordered and obtained from a private vendor. EPA contract laboratories typically do not provide sample containers. Coolers will be obtained from the laboratory, if possible.

The following activities will be completed:

- Review the number of samples to be submitted for analysis.
- Review the analytical requirements, number and type of containers needed, blanks and duplicate requirements, and volumes required.
- Coordinate special analytical requirements with the laboratory QA manager.
- Inform the laboratory of the approximate dates of sampling.
- Schedule shipment of sample containers, labels, chain-of-custody forms.
- Inform the laboratory of the need for analytical results in both hardcopy and electronic formats.
- Preserve samples as required.

Scheduling oversight will be conducted by the RI task manager and project chemist.

2.4 DOCUMENTATION

2.4.1 Field Logbooks

Field logbooks (or daily logs) and data forms are necessary to document daily activities and observations. Documentation will be sufficient to enable participants to reconstruct events that occurred during the project accurately and objectively at a later time. All daily logs will be kept in a bound notebook containing numbered pages. All entries will be made in waterproof ink, dated, and signed. No pages will be removed for any reason. If corrections are necessary, these corrections will be made by drawing a single line through the original entry (so that the original entry remains legible) and writing the corrected entry alongside. The correction will be initialed and dated. Corrected errors may require a footnote explaining the correction.

All field activities will be documented in a bound waterproof logbook. A copy of each logbook will be provided to the EPA at the end of the investigation. A separate logbook will be used by each field party. The following information will be recorded in the logbooks.

- Date and time of entry (24-hour clock)
- Task/activity identification
- Location
- Field measurements
- Weather conditions
- Deviations (if any) from the FSP
- Field observations
- Signature of person making entries
- Methods of sample collection and preservation

Additional minimum documentation required for a given investigation (e.g., boring logs, field data sheets) is described in the specific investigation sections.

2.4.2 Photographs

Photographs will be taken at selected locations as directed by the team leader. Documentation of a photograph is crucial to its validity as a representation of an existing situation. The following information will be noted in the project or task log concerning photographs:

- Date, time, and location where photograph was taken;
- Photographer (signature);
- Weather conditions;
- Description of photograph taken, including view direction;
- Reasons why photograph was taken;
- Sequential number of the photograph and the film roll number;
- Camera lens system used

2.5 COMMUNICATIONS AND REPORTING

All questions regarding the RI field investigations directed toward personnel in the field from the Omega, press, public, state or local agencies and other interested parties will be addressed by the field manager or WESTON's site manager. All inquires regarding purpose will be referred to the EPA.

2.6 FIELD QUALITY ASSURANCE/QUALITY CONTROL SAMPLES

Field QA/QC samples will include trip blanks (VOCs only), equipment rinsate (decontamination) blanks, and field duplicate samples.

2.6.1 Trip Blanks

Transport or trip blanks are used to monitor sample cross-contamination during shipment. Transport blanks will be provided for all samples that will be analyzed for volatile organic compounds. Blanks will consist of laboratory high-performance liquid chromatography-grade (HPLC), carbon-free, deionized water. Blanks will be prepared at the laboratory by filling volatile organic analysis (VOA) vials with water, adding preservative, and sealing. Blanks will be transported unopened to and from the field with environmental samples but will be re-labeled in the field in accordance with Sections 2.1 and 2.3. Transport blank frequency will be one per cooler of VOC samples sent to the laboratory per day.

2.6.2 Equipment Rinsate Blanks

Equipment rinsate blanks (sometimes referred to as decontamination blanks) are used to monitor sample cross-contamination, the effectiveness of decontamination procedures, and contamination in sample containers. Decontamination blanks will be collected by rinsing decontaminated sampling equipment with distilled/deionized water, collecting the rinsate in the appropriate container, and preserving. Rinsate blank frequency will be 5 percent (1 of 20) of samples collected using non-dedicated equipment. These will include groundwater grab samples from push probe boring but not samples from monitoring wells, which will be equipped with dedicated pumps and discharge pipe/tubing. Monitoring wells will be sampled in order from those with lowest concentrations to those with the highest concentrations, to further mitigate the potential for cross contamination between samples.

2.6.3 Field Duplicate Samples

Field duplicate samples are used to assess combined field, sampling, and laboratory variability. Samples will be submitted in duplicate for each sample matrix and analysis combination at a frequency of 10 percent of field samples. Duplicate samples will each be given their own unique sample identifier and will not be identified to the laboratory as such. Duplicates will be collected sequentially for each analyte. For example, the sample bottles for both the field sample and duplicate for volatile organic compounds (VOCs) will be collected first, then the field sample and duplicate for the next analyte following, and so on for all analytes.

2.7 INVESTIGATION-DERIVED WASTE MANAGEMENT

All contaminated or potentially contaminated materials generated during the RI/FS will be managed in accordance with all applicable federal, state, and local regulations. Investigation-derived waste (IDW) will be handled in accordance to applicable regulations and in a manner consistent with ultimate disposition. The IDW materials will be staged at the Omega property until transported for disposal.

2.7.1 IDW Type

IDW is anticipated to include the following categories of waste:

- Nonhazardous solid waste, including personal protective equipment (PPE; e.g., coveralls, gloves), paper towels, other disposable materials, etc.
- Liquid IDW, including well development/purge water and decontamination waste water.
- Soil IDW, primarily soil cuttings from hollow stem auger drilling.
- Drilling mud/soil cuttings from mud rotary drilling.

2.7.2 IDW Storage and Disposition

2.7.2.1 Nonhazardous Waste

Miscellaneous waste will be double-bagged in heavy duty garbage bags, sealed with duct tape, and disposed of in an on-site dumpster for solid waste disposal in a municipal landfill. Excessive contaminated soil or other potentially hazardous waste will be removed from PPE per the site-specific health and safety plan prior to disposal. If PPE cannot be adequately cleaned, it will be containerized for separate disposal or combined with soil cuttings if considered a compatible waste by the disposal facility.

2.7.2.2 Liquid IDW

Liquid IDW will be placed at the point of generation into high-density polypropylene or steel drums, or a portable tank of approximately 500 gallons capacity. The liquids will be transported from the point of generation to the liquids storage pad at the field staging area. Liquids will be transferred by pumping or other means to a larger temporary holding tank or tanks for accumulation prior to disposal. It is anticipated that a considerable amount of water will be generated from well development (approximately 8,100 gallons). Three quarters of low flow monitoring well sampling (the current scope) are anticipated to generate approximately 75 gallons of purge water per sampling event or 225 gallons total. It is assumed the development water will have been disposed by the first sampling event and that drums or a storage tank can be re-used for collecting the sample purge water. Decontamination water from steam cleaning of augers and drilling rods is expected to be generated at the approximate rate of 55 gallons (one drum) per well installation, or approximately 1,100 gallons (20 drums) total.

The storage container(s) will each be affixed or marked with a permanent and unique number on the top and side. The contents of the container (e.g., decontamination water) and the date the contents were first placed in the container will also be conspicuously noted on the exterior of the container. The drummed liquids will be transported from the generation site to the field staging area for temporary storage pending disposal. Containers will be labeled "Not Classified, Potentially Hazardous, Pending Analysis." A WESTON contact's name and phone number will also be marked on the container.

A liner consisting of 50-mil polyethylene sheeting draped over a low rectangular berm of sand bags or similar materials may be constructed for storage of liquid IDW. The storage pad liner would measure approximately 40 x 40 feet in dimension, and be established at the field staging area. Berm sections will be moved as necessary to allow access in and out of the storage pad.

It is anticipated that analytical data from well sampling will generally be sufficient to characterize the liquid IDW for disposal, based on the parameters listed in Table 2. Following receipt of analytical data applicable to the liquid IDW, WESTON will prepare and submit an IDW recommendations memorandum to EPA outlining results, interpretation of waste classification, and suggested disposal.

2.7.2.3 Soil IDW

Soil cuttings from hollow stem auger drilling and mixed drilling mud/soil cuttings generated during mud rotary drilling will be placed in Department of Transportation (DOT) approved 55-gallon steel drums, or in small capacity portable containers. The containers of cuttings will be loaded onto an appropriate trailer and transported to the field staging area. The soil cuttings will be subsequently transferred to metal rolloff containers of approximately ten cubic yard capacity that have been lined with polyethylene sheeting. The rolloff containers will be kept at the field staging area until transported off-site for disposal.

Each drum or container will be affixed with a permanent and unique number on the top and side. The contents of the container (e.g., soil cuttings MW01) and the date the contents were first placed in the drum also will be noted conspicuously on the label. Containers will be labeled

"Potentially Hazardous, Pending Analysis." A WESTON contact's name and telephone number will also be marked on the container. The containers of drill cuttings will be transported to the field staging area for storage pending disposal.

Composite samples will be collected from the drill cuttings (including mud) for analysis to characterize the soil IDW for disposal. A total of five composite samples each from unsaturated and saturated materials (ten total) will be collected from the containerized cuttings. It is anticipated that the analytes listed in Table 2 (TAL metals, pesticides/PCBs, VOCs, and SVOCs) will be sufficient to profile the soil waste for disposal.

Following receipt of analytical results for the containerized IDW, WESTON will prepare and submit an IDW recommendations memorandum to EPA, outlining suggested classification and disposal options. Transport and disposal services will be procured in advance using assumed waste classifications. The analytical data will be required in order to formally establish the waste profile(s) with the disposal facility. Aside from this required step, wastes will be removed from the site as expeditiously as possible.

2.8 CONTINGENCIES

This section describes general procedures to follow when work elements must be changed unexpectedly during implementation of the FSP. Investigation-specific contingency procedures are provided in the individual investigation sections.

Following consultation with EPA, potential contingency actions for the RI/FS will be identified as either minor or significant. Minor changes do not impact the substance of the investigation and may include, but are not limited to, such items as adjusting sample locations [moving a short distance (less than 30 feet) to accommodate a geological or hydrogeologic condition or utilities, collecting additional samples, and adding analyses. Significant changes impact the substance of the investigation and may include, but are not limited to, deletion of samples or analyses, changes in sample locations of more than 30 feet at the discretion of the EPA Work Assignment Manager (RPM) except as noted below, and major changes in data delivery or presentation.

The EPA RPM determine whether a variation from the FSP constitutes a minor or significant change. Once this determination has been made, the following procedures will be followed:

1. Minor changes such as the examples cited above will require verbal notification to the on-site representative (OSR) of the USACE or EPA, if present, or the EPA RPM, with follow-up documentation in the field log or daily report. During the direct push boring groundwater sampling, the USACE OSR will be on-site and will approve sample locations on a daily basis based on lab results from the previous day's sampling. The EPA will be provided daily copies of the proposed sampling locations and given the opportunity to comment on them. The monitoring well locations will be decided in a meeting or conference call following completion of the direct push groundwater sampling, which shall include representatives of WESTON, USACE and EPA.
2. Significant changes and work element deletions will require verbal authorization from the EPA RPM and approval by the USACE OSR before implementation. Written minutes will be prepared summarizing the situation and approved resolution implemented, and forwarded to the approving parties as follow-up.

All such departures from the work plan, FSP and QAPP during the field activities will be summarized in the RI/FS report.

2.9 PERSONNEL HEALTH AND SAFETY

All site work will be performed in accordance with applicable Occupational Safety and Health Act (OSHA) and state regulations. All field team members will have 40-hour heath and training certification, current annual 8-hour refresher training, and current medical surveillance exams. At least one member of the field team will have 8-hour site health and safety coordinator training and certification and be current in first aid and CPR.

SECTION 3

FIELD INVESTIGATION

The field investigation consists of the following elements:

- Task 1—Site Preparation/Presampling Activities
- Task 2—Push Probe Groundwater Investigation
- Task 3—Monitoring Well Installation
- Task 4—Monitoring Well Sampling

These tasks are described in the following sections.

3.1 TASK 1 — SITE PREPARATION/PRE-SAMPLING ACTIVITIES

The objective of this task is to prepare the site for intrusive sampling and facilitate site characterization activities.

3.1.1 Establishment of Field Staging Area

WESTON will establish a field logistics staging area to support the field investigations. The site will also be used for temporary staging of investigation-derived waste (IDW).

The field staging area will include the following:

- A fenced field site, consisting of the southern part of the Omega property. Razor wire is installed atop all fencing. Access is via a locked gate, for which WESTON will maintain its own interconnected lock for the duration that the staging area is utilized.
- A field office trailer supplied with office equipment, laptop computer, telephone, fax, and copy machine.
- A cargo trailer for storage of field sampling equipment and sample containers.
- Electric service will be provided by the facility operating on the Omega property.
- Water service including connection to fire hydrant, meter and service. Water service is for decontamination and hand washing station uses.
- Telephone connection and service.
- Garbage service.
- Security patrol service for 16 hours during weekdays and 24 hours service on weekends for approximately four weeks while the mobile lab is on-site.

- Toilet service including washroom facilities will be furnished by the facility operating at the Omega property.
- Drinking water service.
- Small freezer for on-site storage of ice used during the sampling program and for sample packing and shipping will be designated "For Samples Only" so food and water will not be stored within.

3.1.2 Mobilization of Field Laboratory

WESTON will coordinate scheduling and mobilization of the EPA Field Analytical Support Project (FASP) field laboratory, which will be used for on-site, rapid turnaround analysis of all direct push groundwater samples.

As part of the coordination, the WESTON senior chemist will discuss specifications in the Sampling and Analysis Plan (SAP), and more specifically the Quality Assurance Project Plan (QAPP), with the FASP representative. Items to be discussed will include a description of the analytical method to be employed, required reporting limits, quality control procedures and criteria, and reporting and data deliverable requirements to ensure that data quality objectives (DQOs) are achieved. The Field Sampling Plan (FSP) and QAPP will be forwarded to the FASP laboratory coordinator after review and approval of the EPA and USACE is completed, prior to set-up of the field laboratory on-site.

3.1.3 Personnel Decontamination and Waste Storage Area

A personnel decontamination area will be established as per the site-specific health and safety plan (HSP). The decontamination area will be zoned accordingly and provide potable water for drinking and cleanup, and containers for solid wastes and decon water.

An area for temporary storage of containerized liquid IDW will be constructed at the field staging area. The storage pad will consist of a sheet of 50 mil high-density polyethylene (HDPE), measuring approximately 40 by 40 feet, draped over a perimeter berm. Prior to well construction and development, one or more polypropylene tanks will be placed in the storage area for daily accumulation of liquids. The estimated total capacity needed is approximately 9,000 gallons to accommodate monitoring well development water and decontamination rinsate.

3.1.4 Site Security

Appropriate measures will be taken to secure the staging and drilling locations against unauthorized entry. Site security at push probe and drilling locations will be the responsibility of WESTON. The drilling subcontractor will provide and set up caution tape and barricades or other delineators where necessary to secure the area, as directed by WESTON.

Security at the field staging area will be provided by the existing chain-link fencing and razor wire around the perimeter of the Omega property. A security service will be retained to patrol the site on a 24-hour basis on weekends and on a 16-hour basis weekdays, during the period the FASP mobile laboratory is on-site.

3.1.5 Sampling Access

At least 4 weeks prior to sampling, property owners of sampling areas will be identified and contacted to request access. Private property ownership information will be obtained primarily through the tax assessor's office for the cities of Whittier and Santa Fe Springs.

The information to be obtained for private properties where sampling locations are anticipated should include the following items:

- Street Address
- Facility Name
- Facility Manager's Name
- Facility Telephone
- Owner's Name
- Owner's Address

The information will be used to prepare access letters to be forwarded by EPA to owners of properties where sampling is anticipated.

WESTON will coordinate with municipal agencies to obtain encroachment permits as necessary for drilling access in the City of Whittier, City of Santa Fe Springs, and County of Los Angeles rights-of-way. It is expected that nearly all of the proposed drilling locations will be established within the public way.

Reconnaissance tasks to be conducted in support of providing sampling access includes the following:

- Review of City substructure (underground utility) maps.
- Field verification of drill rig access.
- Field verification of overhead power line locations or other potential overhead hazards.
- Field verification of potential noise or other nuisance concerns to adjacent commercial and residential facilities.
- Premarking of initial and prospective direct push boring and monitor well locations.
- Notifying Underground Services Alert (USA) for marking of known underground utilities.

Well permits will be obtained from the County of Los Angeles, Department of Health Services, Water and Sewerage Section for all monitoring wells and direct push groundwater sample borings.

3.2 TASK 2 PUSH PROBE GROUNDWATER INVESTIGATION

3.2.1 Objectives and General Description

The purpose of the push probe explorations is to characterize the lateral and vertical extent of groundwater contamination associated with Omega site and identify comingled plumes from other sources, if possible. Secondly, results from the push probe investigation will be used in finalizing prospective monitoring well locations.

The push probe investigation will utilize a Cone Penetration Test (CPT) direct push rig to advance up to 100 penetrations for collection of one groundwater sample at each location. Following advancement of the probe to the target depth, a groundwater sample will be collected using either a HydroPunch-type groundwater sampling device deployed from the cone tip, or from temporary one-inch diameter PVC well screen and riser emplaced through the hollow advancement rods. A narrow diameter (approximately 1/2 to 3/4 inch) stainless steel bailer will be used to collect the grab sample.

The water table in the study area is expected to range from approximately 40 to 70 feet bgs. Previous groundwater data indicate that the depth to groundwater is greatest in the vicinity of the Omega property and declines to only 40 feet about one mile downgradient and west of the property. Most of the initial probe samples will be collected at a depth near the base of the first sand aquifer (suspected Gage aquifer), through which most of the shallow groundwater is likely being transmitted. The sand unit is estimated to range in thickness from approximately 20 feet near the Omega site to perhaps 50 feet by one mile down-gradient. The purpose in collecting the majority of the samples from near the base of this unit is to provide data from a consistent interval for comparison of concentration trends in map view. Some of the initial samples will be collected from other intervals within the sand unit, to assess variability in vertical concentration distribution. One groundwater sample will be collected at each probe location, typically from an interval approximately 10 to 20 feet below the water table or as noted above. Sample depths are anticipated to range from approximately 50 to 120 feet bgs.

At approximately 25 of the push probe locations, automatic CPT lithologic logging will be performed, with one pore pressure dissipation test anticipated at each location, as well. Automated CPT logging refers to hydraulically pushing a cone-shaped instrument into the soil, with sensors measuring its resistance to penetration. Since the resistance to penetration is a function of the properties of the soil, the CPT provides a rapid and continuous log of the stratigraphy, relative density and strength of the subsurface soils. Pore pressure dissipation tests evaluate equilibration of pore water pressure, providing an approximation of hydraulic head and the piezometric surface potential of a given depth interval. CPT data will be used in defining the hydrogeology within the study area, especially the distribution of the suspected Gage equivalent sand unit described above. Pore pressure dissipation testing will be used to evaluate approximate lateral and vertical hydraulic gradients.

3.2.2 Sampling Locations and Frequency

The push probe sampling program will contain up to 100 locations and be initiated by selecting approximately 40 provisional locations, field-checking the locations for accessibility, and pre-marking the locations for utility clearance. The approximate locations of the initial push probe explorations are shown in Figure 3-1. These initial locations will focus on establishing lateral delineation of the groundwater plume, filling data gaps, and identifying other PRPs. The exploration will generally proceed outward beginning from areas near the Omega site where existing data is available.

The proposed sampling locations are subject to change depending on accessibility of proposed sample points and sampling results. To the extent possible, groundwater sampling points will be established within public rights-of- way. Negotiated access to private property may be necessary to obtain samples in some instances.

The proposed approach to the push probe exploration is as follows:

- Exploration will begin from areas near the Omega site, where the near-source portion of the plume is somewhat characterized as to concentrations and, to a lesser degree, lateral extent (Figures 1-5 and 1-6). Data from the first one to two rows of sample points will be primarily used to confirm the lateral extent of the plume cross-gradient in the immediate vicinity of the Omega site.
- Following establishment of the initial line of sample locations, the exploration will pursue an irregular grid of approximately 500 to 1,000 feet nodal spacing, laid out in the down-gradient direction from the Omega site. The study area extends toward the west-southwest from the Omega site for approximately 7,000 feet; to the vicinity of public supply well 2S/11W-30R3 (City of Santa Fe Springs Well No. 1), near Dice Road south of Slauson Avenue.
- If the lateral boundaries of the plume can be identified inside the limits of the grid, and planned locations prove to be outside the plume boundary, those borings may be eliminated and/or substituted elsewhere.

Subsequent direct push explorations (approximately 60 remaining locations) will focus on delineating potential alternate source areas or vertical extent of contamination, or resolving specific data gaps identified during the initial explorations. Ability to evaluate deeper lithologies and vertical extent of plumes may be limited by the depth of probe refusal, especially where dense sand, gravel, or cemented layer may be encountered. Most of that data will probably be provided by the monitoring well explorations.

Establishment of additional push probe sampling locations will be conducted as a continuous process, using the results of real time laboratory analysis of samples collected to that point to determine locations. All prospective push probe locations will be approved by the USACE OSR and by the EPA PM prior to placement, typically on a daily basis.

3.2.3 Field Procedures

3.2.3.1 Locating Sampling Stations

The chosen locations of the push explorations will be pre-marked with paint by the field manager in the field prior to utility clearance. Underground Service Alert (USA, 1-800-422-4133) will be notified at least two days prior to drilling at given locations, to allow utility companies to mark their underground lines in the vicinity of those locations.

3.2.3.2 Direct Push Boring Procedures

The push probes will be advanced using a truck-mounted CPT rig as noted above. Direct push borings are advanced using hydraulic controls to bring the weight of the rig vehicle to bear on a cone tip and hollow extension rod, driving them into the substrate. The down pressure capacity of a CPT rig is approximately 25 tons. Depending upon the actual use of the boring, the cone tip may consist of a cone penetration sensing apparatus, a HydroPunch groundwater sampling device, or a simple detachable head. Personnel aboard the CPT rig include an operator, who runs the controls, tracks automated logging, etc., and a helper, who adds extension rods, prepares equipment, and assists with sampling.

The CPT rig readily advances through most soils, with the exception of hard debris, coarse gravel, and very dense sand or gravel. CPT borings may be advanced to depths of 90 feet or even more, depending upon subsurface conditions. The maximum achievable depth in favorable conditions could approach 125 feet. No push probes will be advanced beyond the point of refusal as determined by the rig operator.

For the 25 locations where automated logging is to be performed, the cone penetration sensing apparatus will be attached as the tip. As the rod is advanced, the cone sensor transmits physical parameters to be recorded and interpreted by an on-board computer including tip resistance or cone bearing, sleeve friction, and dynamic pore pressure, at 5 cm intervals. Lithologic interpretation is based on relationships between these three parameters, especially the sleeve friction to cone bearing ratio, which provides the friction ratio. In general, more cohesive soils like clays have high friction rations, low cone bearing values, and large excess pore water pressures. Cohesionless soils like sands have lower friction rations, high cone bearing values, and generate little excess pore water pressures. The on-board computer will plot the key parameters and generate an interpreted stratigraphic log for the borings.

Pore pressure dissipation tests will be performed at selected intervals in borings where automated CPT logging is conducted, using the same cone penetration sensor tip. Hydrostatic water pressures are measured, yielding the approximate depth to water table based on the equilibrium pressure recorded at the given depth interval. Horizontal permeability may also be estimated based on the time required for 50 percent of the measured dynamic pore pressure to dissipate. A report summarizing the results of the automated logging and pore pressure dissipation testing including the stratigraphic logs and dissipation curves, will be prepared by the company performing the CPT drilling.

All direct push borings will be abandoned by backfilling with grout made with water, Portland cement and approximately 5 percent bentonite gel, using a support truck dedicated for that purpose. The grout will be thoroughly mixed to a consistency that can be readily pumped. A hollow CPT rod will be run back into the hole for use as a tremie pipe. Alternately, PVC pipe will be placed into the advancement rods after logging or sampling are completed, and the rods will be withdrawn, leaving the PVC for use as a tremie. The grout will be pumped through the tremie pipe, filling the boring from the bottom up. The tremie pipe will be withdrawn in stages as the boring fills, to avoid either free-fall of grout into water, or grouting the tremie pipe in the hole. Once the grout reaches the surface, it will be allowed to settle for approximately one hour or more. The hole will be topped off to within approximately six inches of the surface, and rapid-set concrete will be used for surface repair. A typical abandonment diagram for the push probe borings is included in Appendix B.

3.2.3.3 Groundwater Grab Sampling Procedures

Grab samples of groundwater will be collected at up to 100 direct push borings, using either a HydroPunch sampling device or a temporary PVC well screen. Procedures for each method are summarized below.

The HydroPunch is a sampling tool constructed of stainless steel and teflon that is attached as the drive point to the CPT probe. A new, disposable PVC intake screen is used with a sample collection chamber fitted between two check valves, telescoped within the cone tip assembly. The sampling tool and rod are advanced to the target sampling depth, which will be recorded as one foot above total depth. The rod is withdrawn approximately two feet, disengaging the cone tip and exposing the screen. One minute is allowed to pass in order to provide ample time to fill the reservoir and flow through the upper check valve (if the upward gradient is sufficient at the sample point). The sample device with its reservoir filled is brought to the surface by withdrawing the rod. The check valves retain the sample in the collection reservoir. The water sample will be decanted from the collection reservoir into unpreserved, 40 ml sample vials, pouring the sample carefully down the side of the container to minimize aeration or possible volatilization. The SOP for groundwater sampling using a HydroPunch direct push sampler is provided in Appendix A.

If recovered sample volumes are insufficient, or the HydroPunch device experiences disengaging difficulties or short fills, a method employing a section of one-inch diameter temporary PVC well screen will be instituted. The drive head will be fitted with a sacrificial cone tip, and advanced to the desired sampling depth, which will be recorded as two feet above the total boring depth. A five-foot section of 0.010-inch slotted well screen will be sent down the rod to the bottom of the boring and the cone tip will be jettisoned by withdrawing the rod approximately four feet. This will expose the boring sidewall adjacent to the screen, while higher intervals will be sealed off by the hollow rod. A decontaminated, stainless steel bailer will be carefully lowered to the midpoint of the screened interval so as to minimize disturbance of the sample and possible loss of volatiles. The filled bailer will be smoothly and rapidly retrieved to the surface. The sample will be decanted from the bailer into unpreserved, 40 ml sample vials, pouring the sample carefully down the side of the container to minimize aeration or possible volatilization.

The sample vials will be filled to a protruding meniscus and the lids will be snugly attached. The vials will be inverted and lightly tapped to check for bubbles; if none are observed larger than 2 mm in diameter, the bottle will be deemed acceptable for submission to the on-site FASP laboratory. A photoionizing detector (PID) or flame-ionizing detector (FID) will be used to screen remaining groundwater matrix for organic vapors. The background and sample readings will be recorded and verbally characterized or ranked as described in Table 4. Any PID/FID readings above background or apparent odors will be reported to the on-site laboratory. That information may aid the laboratory in identifying samples with excessively elevated contaminant concentrations, so instrument contamination and time consuming cleaning or recalibration may be avoided.

The samples will be labeled according to the conventions described in Section 2 of this document, placed in resealable plastic bags, and placed on ice in a chilled cooler. The sampling technician will deliver the sample to the on-site field laboratory and log the sample on a chain-of-custody at the laboratory. The samples will be stored at the laboratory in a refrigerator at approximately 4 degrees Celsius until analysis. The laboratory will provide analysis of volatile organic compounds well within the specified 7-day hold time for unpreserved samples.

Before abandoning the boring, the depth to water will be sounded using an electronic water level indicator. The depth to water will be recorded on the sampling form and in the log book.

3.2.3.4 Surveying

Global positioning system (GPS) units will be used to identify the location coordinates of the push probe sampling stations for integration into the Geographic Information System (GIS) database. GPS coordinates will be provided in a summary table along with the other push probe data (e.g., sample depth, total depth). GPS accuracy is adequate for locating the direct push sample points.

Alternately, direct push sampling locations may be determined by tape measurements from two or more identifiable fixed locations. In this case the sample locations will be hand plotted to scale on a coordinate-based map with an aerial photograph overlay. In order to incorporate the locations into the database, it will be necessary to then digitize the hand-plotted locations.

Regardless of the method used to define the sample locations, estimated locations will be hand plotted on a field copy of the base map as the samples are completed. This will aid in understanding the delineation of the plume, as data are reviewed with the USACE OSR on a daily basis.

3.2.4 Sample Analysis

The groundwater samples from the push probe explorations will be analyzed for VOCs by the on-site EPA FASP laboratory. Analysis will be performed by Gas Chromatography, with Mass Spectrometry confirmation (GC/MS). Most samples will first be analyzed using a Leybold-Inficon Hapsite® field portable GC/MS to determine approximate concentrations. The Hapsite results will be used to determine the necessary dilutions, if any, that must be performed in order to analyze the samples using the FASP GC/MS without exceeding the upper calibration range. The target analytes for the groundwater grab samples are halogenated VOCs; principally PCE and its breakdown products, plus Freon 11 and Freon 113. Analytical methods and procedures will be as prescribed in ESAT Region 9 Laboratory Standard Operating Procedures (SOPs) #902, "FASP Volatile Organic Compound Analysis by GC/MS," and #910, "Measurement of Volatile Organic Compounds (VOCs) in Gaseous Matrices." These SOPs are included in Appendix B of the QAPP.

A sampling summary with analytical methods, preservation, holding times, and container requirements is presented in Table 2. The estimated numbers of field and QA/QC samples to be analyzed, the numbers of sample containers, and precision/accuracy requirements are summarized in Table 3. The list of target analytes and requested detection limits for undiluted samples is included in Appendix C of the QAPP. The proposed detection limits will apply to undiluted samples of low contaminant concentration, typically obtained from the margins of the plume. Where higher VOC concentrations in the 1,000 ug/L range are encountered along the near-source or central portion of the plume, detection limits will be raised by dilutions, and estimated values will be reported for the higher concentration analytes.

The laboratory will provide daily summaries of results, which will be used in determining or confirming upcoming, prospective sample locations.

3.2.5 Contingency Procedures

General contingency procedures related to deviations from the FSP and RI/FS Work Plan are discussed in Section 2.8. A potential contingency specific to push probe advancement is described below.

Drilling refusal occurs when impenetrable materials are encountered and necessary advancement pressure either becomes greater than the weight of the CPT vehicle, or creates a risk of damage to drilling tools and/or rods. The impenetrable materials may be man-made, such as concrete debris, or may be natural, such as dense, coarse-grained or cemented lithologies. If refusal occurs above the designated sampling depth, the boring will be terminated and the boring will be abandoned as described above. Subsequently attempted boring(s) will be advanced within 30 feet of the original location. The decision to terminate the sampling effort will be made by the on-site geologist or engineer and both USACE and EPA will be advised of the termination and re-location.

3.3 TASK 3—MONITORING WELL INSTALLATION

3.3.1 Objectives

After the CPT data have been reviewed and approved by the EPA and USACE, and proposed locations are approved, approximately twenty monitoring well will be installed. The groundwater monitoring wells will be used for long term monitoring and risk assessment. The monitoring wells will be constructed and installed using a combination of hollow stem auger (HSA) drilling and mud-rotary methods in general accordance with the standard requirements of the Los Angeles County Department of Health Services, the local permitting agency, and California Department of Water Resources Bulletins 74-81 and 74-90, *California Well Standards* (1981/1991).

Specific well numbers, provisional screen depths, and locations will be determined following review of the groundwater grab sampling data with the USACE OSR and EPA RPM. No wells will be installed until USACE and EPA approves their proposed location and construction.

A general discussion of drilling techniques and well installation is described below with applicable SOPs included in Appendix A.

3.3.2 Sampling Locations and Frequency

The monitoring well locations will be determined after completion of the push probe groundwater investigation. Monitoring wells sites will be chosen to evaluate changes in the extent (size, shape) or character (i.e., concentrations) of the plume, and determine whether deeper aquifers are impacted or potentially threatened upgradient of the nearest receptor, the City of Santa Fe Springs Well No. 1. As such, wells will be sited primarily along central portions and near boundaries of the plume as defined by the push probe investigation. The wells will be sampled on a quarterly basis to monitor the plume.

The proposed monitoring wells will include:

- Ten 4-inch ID wells installed using standard HSA drilling methods and screened across a ten-foot interval at approximately 50 to 70 feet bgs;
- Five 4-inch ID wells installed using HSA drilling methods and screened across a ten-foot interval at approximately 90 to 110 feet bgs; and,
- Five 4-inch ID wells installed using mud-rotary methods and screened across a ten-foot interval at approximately 150 to 170 feet bgs.

3.3.3 Field Procedures

A discussion of field methods and SOPs applicable to drilling and lithologic sampling is included in Appendix A. Diagrams of typical well constructions are included in Appendix B.

3.3.3.1 General Approach

Drilling will be conducted using a qualified drilling contractor. All drilling activities will be supervised by a WESTON geologist. The shallower wells (less than 110 feet bgs) will be drilled and installed using truck mounted hollow-stem auger (HSA) drilling rigs equipped with 10-inch nominal outside-diameter (OD) augers. Pilot borings will be advanced at all HSA locations, with 8-inch nominal OD augers used to advance the pilot borings. The 8-inch pilot borings will be reamed with 10-inch nominal OD augers prior to installation of the well casing, screen, and annular fill materials.

Deeper wells (greater than 110 feet bgs) will be drilled and installed using mud rotary drilling equipment. Deeper wells will be drilled and constructed using truck mounted mud rotary drilling equipment. To maintain the boring sidewalls, bentonite slurry with a density of 9 to 13 pounds/gallon will be introduced through the drill stem. Mud will be recirculated in the boring using a mud pit or similar collection mechanism to recover and separate drill cuttings.

3.3.3.2 Pilot Soil Borings

Soil borings will be advanced with a hollow-stem auger (HSA) drill rig according to the procedures described in American Society for Testing and Materials (ASTM) D1452-80, *Standard Practice for Soil Investigation and Sampling by Auger Borings*. Drilling will be conducted in accordance with the Los Angeles County Department of Health administrative rules (OAR-690-200).

Continuous sampling will be conducted while drilling the pilot borings using a split core barrel five feet in length. The general sample collection procedure for soil borings is as follows:

1. Drill to the desired sample depth.

2. Drive the split-spoon core barrel (unlined) approximately five feet into the soil using a 300-pound geotechnical drilling rig hammer with a 30-inch-drop height.
3. Record the blow counts for every 6 inches of sampler penetration. The blow count data will give an indication of the penetration resistance.
4. Drill down to near the sampler tip.
5. Retrieve the split-spoon core barrel from the boring.
6. Obtain an aliquot of the most apparently contaminated portion of soil and proceed with headspace organic vapor screening as described below.
7. Classify the soil according to the Unified Soil Classification System (USCS; ASTM 2488) and record on a standardized field sampling form, or an equivalent soil description log form. The relative recovery will be noted, and the lithology will be described for the depth interval of the recovered portion. Evidence of contamination, such as staining, sheen, free product, or odor, will also be noted on the field sampling form.
8. Composite samples will be collected of soil recovered from the core barrel or from cuttings/mud to represent both unsaturated and saturated intervals within the boring. The composite samples will be analyzed to characterize drill cuttings for subsequent disposal.
9. Describe the sample location on the field record form. Photograph sampling stations/well locations. Document the roll of film, photograph number with respect to film roll, date, location and direction of photo, and other pertinent information such as personnel or points of interest in the photo.

3.3.3.3 Soil Boring Abandonment

If necessary, borings will be abandoned in accordance with the Los Angeles County Department of Health administrative rules. Borings less than 15 feet deep will be abandoned using bentonite chips. Deeper borings will be abandoned with bentonite grout with density between 9 and 13 pounds per gallon. Auger flights will be removed sequentially as the boring is filled with grout using a tremie pipe or hose. The upper approximately one foot of the borehole will be filled with bentonite chips and hydrated with approximately 2 gallons of water. On preexisting paved areas, rapid-set concrete or asphalt cold patch will then be introduced to a level very slightly crowned above the surrounding ground surface.

3.3.3.4 Head Space Screening

Selected soil from approximate five-foot depth intervals in each monitoring well pilot boring will be screened for the presence of organic vapors using either a FID or PID. These detectors are capable of detecting the concentration of primarily organic vapors in parts per million relative to a known standard. The instruments can be calibrated to a particular compound but cannot distinguish between compounds in a mixture of gases. Readings obtained with the detector will be reported in units and assigned a relative ranking according to Table 4.

The headspace VOC screening procedure is as follows:

1. Calibrate the PID or FID according to manufacturer's instructions.
2. Fill a small resealable plastic bag approximately half full and seal. Note the time on the field log form.
3. Allow the sample to remain undisturbed for 2 to 5 minutes.
4. Insert the detector tip and position within the enclosed headspace above the soil and record the maximum reading in units. Assign a ranking designation according to Table 4 and record on the field log form.

3.3.3.5 Monitoring Well Installation

Wells will be constructed in accordance with the following requirements:

- Los Angeles County Department of Health permitting requirements,
- California Department of Water Resources Bulletins 74-81 and 74-90, *California Well Standards* (1981, 1991); and,
- Any additional requirements stipulated by the EPA RPM.

Each pilot boring will be reamed to approximately ten-inches nominal diameter before construction of the wells. Upon reaching the total depth of the borehole, well materials will be prepared for installation. Only well materials that have been delivered properly cleaned and protected with plastic wrapping by the manufacturer will be accepted for installation.

All wells will be constructed using 4-inch ID, Schedule-40 PVC casing materials and well screens. Well screens will be ten feet in length. Both 0.010-inch ("10-slot") and 0.020-inch slot well screens will be available on site. The appropriate screen will be determined in the field based on the lithologies observed in the continuous cores. The 10-slot screens will be used with filter packs of pre-washed silica #2/16 sand, for screening across intervals with significant fines (e.g., sandy silt to silty fine sand). The 20-slot screens will be used with filter packs of pre-washed silica #3 sand, for screening across medium sand or coarser lithologies.

All casing and screen sections will be coupled with flush-threaded joints and wrapped with Teflon tape, or Viton O-rings will be used. No petroleum-based lubricants, glues, or epoxies will be used to join sections of casing or pipe. The well screen assembly is lowered to the bottom of the boring. For deep wells at least three centralizers and for the intermediate depth shallow wells two centralizers will be installed, to aid in keeping the casing straight and facilitate even installation of annular materials.

The annulus around the well screen will be slowly filled with sand pack material as described above to a level approximately 24 inches above the well screen. A surge block will be used to settle and consolidate the filter pack. Additional filter pack material will be placed if necessary to reach the level specified above. The level at the top of the sand pack will be checked with a weighted measuring tape both during addition of filter material, and at the final consolidated level.

A three- to five-foot bentonite chip or coated Volclay bentonite pellet seal (for seal below water table) will be placed above the filter pack. The level at the top of the seal will be measured as described for the sand pack. If the seal is above the water table, potable water will be added to hydrate the bentonite pellets prior to grouting the remainder of the borehole. The annulus above the seal will be filled with a Portland cement/bentonite grout containing approximately 6.5 gallons of water and 4 pounds of powdered bentonite for each 96-pound bag of cement. The constituents will be combined in a grout mixer and pumped down the annulus through a tremie pipe, and allowed to set undisturbed at least 48 hours prior to well development.

The auger flights will be withdrawn from the borehole as the various packings are placed in the annulus to minimize caving of boreholes during installation. Sealing materials will be placed in a continuous process from the bottom up using a grout or tremie pipe. The volume of filter pack and sealants needed to fill the annular space will be calculated by the WESTON field representative prior to placement. Any discrepancies between this calculated volume and the actual amount used will be noted and reconciled to ensure the integrity of the filter and seals.

The PVC well casing will be cut off below grade with a PVC cutter, equipped with a locking cap and a water-tight end plug. The surface completion will consist of a traffic-rated well box placed in rapid-set concrete. A well installation SOP is included in Appendix A.

3.3.3.6 Monitoring Well Development

Newly installed monitoring wells will be developed to remove suspended material and drilling fluids from the surrounding formation, filter pack, and well screen to establish hydraulic continuity with groundwater. Wells will be developed with a submersible pump. All well development equipment will be decontaminated prior to downhole use. Water quality parameters consisting at a minimum of temperature, specific conductance, pH, and turbidity will be measured and recorded at least three times during development. Development will proceed until the removed water appears clear visually and is free of sediment and the water quality parameters have stabilized within 10 percent between successive readings, or until as much as 10 casing volumes are removed.

Well development will be performed by the drilling contractor with a truck mounted rig, under WESTON's oversight. Wells will be developed in order of increasing suspected contamination. Well development methods will include swabbing/surging, bailing, and pumping with a submersible pump. A surge block technique will be favored to loosen and clean out fine material.

The surge-block development will be performed as follows:

- A weighted surge-block or "swab" attached to a rigid pipe or a line will be lowered into the upper two feet of the well screen. A surge-block is cylindrical, with a diameter approximately 0.2 inches less than the ID of the well casing and screen. Water can flow between the block plate and well screen. The surge-block is used to gently agitate the water by moving the swab in a continuous up and down motion.

- After 5 to 10 minutes of swabbing, the surge-block is removed from the well and groundwater is bailed to remove sediments. Additional agitation caused by bailing will further develop the well.
- The next two-foot section of the saturated well screen will then be swabbed as described above, and the first two steps are repeated, until the entire screen has been treated in this manner.
- After a final bailing of sediment, water will be pumped from the well using a submersible pump, at an assumed rate of 1.5 gallons per minute (gpm).

WESTON anticipates that an average of approximately 4 hours per well will be required for development; however, the duration at each well will be determined in the field by the WESTON representative based on well yield and turbidity of produced water. Wells will sit undisturbed a minimum of 24 hours after development and before sampling.

Dedicated bladder pumps of stainless steel construction will be installed in each well using the development rig after each well has been developed. Pumps will have maximum flow rates of approximately 0.65 to 1.25 gallons per minute (gpm). Dedicated discharge tubing will be fitted to the pump, consisting of 3/8-inch to 1/2-inch diameter, Teflon-lined, polyethylene tubing. A replacement well cap with openings to accommodate the compressed air and discharge tubing will be placed on the well. A compatible electronic control box will be obtained so flow rates can be closely adjusted during low flow purging and sampling.

3.3.3.7 Monitoring Well Surveying

Each of the 20 monitoring wells will be surveyed as to location and elevation by a licensed surveyor. The surveyor will develop coordinates for the surveyed points in a form compatible with the proposed GIS database. The survey points are defined as the north rim of the top of the casing of the monitoring wells and will be marked with indelible pen or small saw cuts.

The survey procedures for horizontal measurements will follow the guidelines below:

- Horizontal accuracies will be plus or minus 1 foot for monitoring wells.
- The horizontal datum of reference will be the North American Datum of 1983, 1991 adjustment (NAD91). Coordinates will be reported in the California State Plane Coordinate System, North Zone, in U.S. survey feet.

The survey procedures for vertical measurements will follow the guidelines below:

- Vertical positions will be determined using differential leveling methods. All points will be included in closed circuits or double-tied from points that are included in a closed circuit.
- Vertical accuracies will meet or exceed the following specifications:
  - Top of casing elevations—plus or minus 0.01 foot.
  - Concrete or ground surface elevations—plus or minus 0.01 foot.
- The vertical datum of reference will be the North American Vertical Datum of 1988 (NAVD88).

3.3.3.8 Water Level Measurement

Water level measurements will be collected from all RI wells and PRP wells prior to groundwater sampling. Water levels will be measured using an electronic water level probe from the top of the well casing (survey point) to the nearest 0.01 foot. The total well depth also will be measured after sampling each well, and compared to well construction diagrams to assess accumulated solids in the well. The SOP for water level measurement is included in Appendix A.

Water level sounding equipment will be decontaminated before and after use in each well. Water levels will be sounded beginning with wells which have the least suspected or known contamination first.

3.3.4 Sample Analysis

Analysis of ten (10) composite soil samples collected during well installation will be conducted only for disposal characterization. The proposed analyses are summarized in Table 2. Disposal characterization analyses will be performed by an EPA regional or contract laboratory.

3.3.5 Contingency Procedures

General contingency procedures related to deviations from the FSP and RI/FS Work Plan are discussed in Section 2.8. A potential contingency related to the monitoring well installation is discussed below.

Drilling refusal may occur because of debris or dense, cemented, and/or coarse native sediment that may be encountered. If refusal occurs the boring will be terminated and the boring will be abandoned as described in the previous subsection. Subsequent borings will be advanced within 30 feet of the original location. The decision to terminate the drilling effort at a given will be made by the field manager in consultation with WESTON's site manager, the USACE OSR, and the EPA RPM.

3.4 TASK 4 ROUTINE GROUNDWATER SAMPLING

3.4.1 Objectives

The purpose of routine groundwater sampling is to develop a record of representative contaminant concentrations at the monitoring well locations over a period of time. This historical record may be used to evaluate plume movement or change, stability or variability of contaminant concentrations, and potential new influxes of contaminants from other sources besides Omega.

3.4.2 Sampling Locations and Frequency

Groundwater samples will be collected from the twenty RI wells and initially, from the eight existing wells installed by the PRP near the Omega site as well. Samples will be collected quarterly, and results will be summarized in quarterly monitoring reports.

3.4.3 Field Procedures

Low flow purge and sampling techniques will be used. The low-flow sampling procedure is presented in the SOP and related attachment, included in Appendix A.

Purging will continue until water quality parameters (i.e., dissolved oxygen, pH, temperature, redox potential, and specific conductance) are determined to have stabilized within the range indicated in the SOP. Representative groundwater can then be sampled.

3.4.4 Sample Analysis

A fixed laboratory or laboratories that are part of the EPA's Contract Laboratory Program (CLP) will analyze monitoring well samples. CLP procedures including specific chain-of-custody procedures and secondary unique numbering of samples will be implemented.

The groundwater samples will be initially analyzed for a full suite of analytical parameters (VOCs, SVOCs, dissolved metals, chlorinated pesticides, PCBs, cyanide, perchlorate, and water chemistry parameters (Total Dissolved Solids[TDS] and alkalinity). The samples will also be analyzed for natural attenuation parameters including dissolved organic carbon, nitrate/nitrite, sulfate, sulfide, and methane/ethenes/ethanes. The list of proposed analyses and requested detection limits is included in Appendix C of the QAPP.

Analysis of general water chemistry parameters and natural attenuation parameters will be conducted during the initial round and annually thereafter. Analyses for particular contaminants of concern other than VOCs will be eliminated for given well locations if consistent non-detect or background results are reported for three consecutive quarters or more.

SECTION 4

REFERENCES

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Tables

Table 1—Historic Push Probe Sample Depths Summary
Omega Chemical RI/FS
Whittier, California

Boring ID	Total Depth (ft. bgs)[a]	Approximate Sample Depth (ft. bgs)
H-1	90	71-84
H-2	124	70-85
H-3	85	70-85
H-4	101	57-72; 70-85
H-5	69	No GW Sample
H-6	116	NA
H-7	97	NA
H-8	90	NA
H-9	72	NA
H-10	93	NA
H-11	95	NA
H-12	122	NA
H-13	85	NA
H-14	66	43
H-15	75	38-48
H-16	53	40-50
H-17	76	30-40

Notes: NA = Not Available
Reference: Technical Memorandums 6 and 11, England and Hargis, 1996.

Table 2—Sample Analyses Summary
Omega Chemical RI/FS
Whittier, California

Matrix	Location[a]	Analytical Parameters and Method	Sample Preservation	Technical Holding Time[b]	Sample Container(s)
Soil/ Sediment		TAL metals (CLPAS) ILM04.1 / SW846 6010B/7471	Cool to 4 °C ± °C	180 days from collection (28 days for mercury)	One 8-oz. wide-mouth glass jar with polyethylene-lined lid
		Pesticides/PCBs SW846 - 8081A/8082	Cool to 4 °C ± 2 °C	Extract within 14 days of collection; analyze within 40 days of extraction	One 8-oz. wide-mouth glass jar with Teflon-lined lid
		VOCs SW846 - 8260B	Cool to 4 °C ± 4 °C	14 days from collection	One 2"x6" brass sleeve with Teflon covers and polyethylene end caps
		SVOCs SW846 - 8270C	Cool to 4 °C ± 2 °C	Extract within 14 days of collection; analyze within 40 days of extraction	One 8-oz. wide-mouth glass jar with Teflon-lined lid
Water		TAL metals (CLPAS) ILM04.1 / SW846 6010B/7470	Cool to 4 °C ± 2 °C; HNO_3 to pH ≤ 2	180 days from collection (28 days for mercury)	One 1-L polyethylene bottle with polyethylene-lined lid
		Pesticides/PCBs SW846 - 8081A/8082	Cool to 4 °C ± 2 °C	Extract within 7 days of collection; analyze within 40 days of extraction	Two 1-L amber glass jars with Teflon-lined lids
		VOCs SW846 – 8260B	Cool to 4 °C ± 2 °C; HCl to pH ≤ 2	14 days from collection	Two 40 mL jars with Teflon-lined septa
		SVOCs SW846 – 8270C	Cool to 4 °C ± 2 °C	Extract within 7 days of collection; analyze within 40 days of extraction	Two 1-L amber glass jars with Teflon-lined lids
		TOC EPA 415.1	Cool to 4 °C ± 2 °C H_3PO_4 to pH ≤ 2	28 days from collection	Two 40 mL jars with Teflon-lined septa
		Methane, Ethane, Ethene RSK175	Cool to 4 °C ± 2 °C	7 days from collection	One 125-mL amber glass bottlewith Teflon lined lid
		Total Dissolved Solids EPA 160.1	Cool to 4 °C ± 2 °C	7 days from collection	One 1-L polyethylene bottle with polyethylene-lined lid
		Chloride/Sulfate EPA 300.0	Cool to 4 °C ± 2 °C;	28 days from collection	One 250-mL polyethylene bottle with polyethylene-lined lid
		Alkalinity SM 2320	Cool to 4 °C ± 2 °C;	14 days from collection	One 500-mL polyethylene bottle with polyethylene-lined lid
		Perchlorate EPA 300.0M	Cool to 4 °C ± 2 °C;	28 days from collection	One 250-mL polyethylene bottle with polyethylene-lined lid
		Total Cyanide EPA335.3	Cool to 4 °C ± 2 °C; NaOH to pH>12	14 days from collection	One 500-mL polyethylene bottle with polyethylene-lined lid
		Nitrate-Nitrite Nitrogen as N EPA 353.2	Cool to 4 °C ± 2 °C H_2SO_4 to pH ≤ 2	28 days from collection	One 500-mL polyethylene bottle with polyethylene-lined lid

Table 2—Sample Analyses Summary
Omega Chemical RI/FS
Whittier, California

Matrix	Location[a]	Analytical Parameters and Method	Sample Preservation	Technical Holding Time[b]	Sample Container(s)
QC Water Samples	Trip Blank	VOCs SW846 – 8260B	Cool to 4 °C ± 2 °C; HCl to pH ≤ 2	14 days from collection	Two 40-mL jars with Teflon-lined septa
	Rinsate Blank and Duplicate	TAL metals (CLPAS) ILM04.1 / SW846 6010B/7470	Cool to 4 °C ± 2 °C; HNO_3 to pH ≤ 2	180 days from collection (28 days for mercury)	One 1-L polyethylene bottle with polyethylene-lined lid
		Pesticides/PCBs SW846 – 8081A/8082	Cool to 4 °C ± 2 °C	Extract within 7 days of collection; analyze within 40 days of extraction	Two 1-L amber glass jars with Teflon-lined lids
		VOCs SW846 – 8260B	Cool to 4 °C ± 2 °C; HCl to pH ≤ 2	14 days from collection	Two 40-mL jars with Teflon-lined septa
		SVOCs SW846 – 8270C	Cool to 4 °C ± 2 °C	Extract within 7 days of collection; analyze within 40 days of extraction	Two 1-L amber glass jars with Teflon-lined lids

Notes:
[a] The number of samples presented is an estimate; the actual number of samples to be collected will be determined in the field.
[b] Technical holding times have been established only for water matrices. Water technical holding times were applied to sediment, soil, and product samples where applicable; in some cases, recommended sediment/soil holding times are listed.
C: Celsius.
CLPAS: Contract Laboratory Program Analytical Service.
HCl: Hydrochloric acid.
HNO_3: Nitric Acid.
L: Liter.
mL: Milliliter.
oz: Ounce.
PCBs: Polychlorinated Biphenyls.
Pesticides: Chlorinated Pesticides.
SVOCs: Semivolatile Organic Compounds.
TAL: Target Analyte List.
VOCs: Volatile Organic Compounds.

Table 3—QA/QC Analytical Summary and Fixed Laboratory Analytical Methods
Omega Chemical RI/FS
Whittier, California

Laboratory	Matrix	Parameters/ Method	Method Description/ Detection Limits	Total Field Samples[a]/ Containers	QA/QC Sample Summary Analyses/Containers					Total Field and QA/QC Analyses/ Containers[f]	Precision and Accuracy
					Organic MS/MSD[b]	Inorganic MS/Dup[b]	Field Duplicates[c]	Rinsate Blanks[d]	Trip Blanks[e]		
Field Analysis	Soil/ headspace	VOCs/(CLPAS) FASP SOP #910	Per SOP	TBD/TDB	NA	NA	NA	NA	NA	TBD/TBD	Screening only
EPA Region 9 or CLP Laboratory	Soil - IDW	Diss. TAL Metals/ (CLPAS) ILM04.1	AA & ICP/ CRDL	10/10	NA	1/0	1/1	1/1	NA	13/12	75% - 125% +/- 35%
		Pesticides/PCBs (CLPAS) OLM04.2	GCS & ECD/ CRQL	10/10	1/0	NA	1/1	1/2	NA	13/13	OLM04.2/ OLM04.2
		VOCs/ (CLPAS) OLM04.2	GCS & MD/ CRQL	10/10	1/0	NA	1/1	1/2	NA	13/13	OLM04.2/ OLM04.2
		SVOCs/ (CLPAS) OLM04.2	GCS & MD/ CRQL	10/10	1/0	NA	1/1	1/2	NA	13/13	OLM04.2/ OLM04.2
EPA Region 9 FASP close-support laboratory	Water – Push Probe	VOCs/ (CLPAS) FASP SOP #902	Per SOP	100/300	5/15	NA	10/30	5/15	NA	120/360	Per SOP
EPA Region 9 or CLP Laboratory	Water – Monitoring Wells	Pesticides/PCBs (CLPAS) OLM04.2	GCS & ECD/ CRQL	20/40	1/2	NA	2/4	1/2	NA	24/48	OLM04.2/ OLM04.2
		VOCs/ (CLPAS) OLM04.2	GCS & MD/ CRQL	20/60	1/3	NA	2/6	1/3	1/3	25/75	OLM04.2/ OLM04.2
		SVOCs/ (CLPAS) OLM04.2	GCS & MD/ CRQL	20/40	1/2	NA	2/4	1/2	NA	24/48	OLM04.2/ OLM04.2
		Diss. TAL Metals/ (CLPAS) ILM04.1	AA & ICP/ CRDL	20/20	NA	1/1	2/2	1/2	NA	24/25	75% - 125% +/- 35%

Table 3—QA/QC Analytical Summary and Fixed Laboratory Analytical Methods
Omega Chemical RI/FS
Whittier, California

Laboratory	Matrix	Parameters/ Method	Method Description/ Detection Limits	Total Field Samples[a]/ Containers	QA/QC Sample Summary Analyses/Containers					Total Field and QA/QC Analyses/ Containers[f]	Precision and Accuracy
					Organic MS/MSD[b]	Inorganic MS/Dup[b]	Field Duplicates[c]	Rinsate Blanks[d]	Trip Blanks[e]		
		Methane Ethane Ethene/RSK-175	GCS & MD/ 1 ug/L	20/40	1/2	NA	2/4	1/2	1/2	25/47	70% - 130% +/- 30%
		Total Dissolved Solids/EPA 160.1	Gravimetric/ 5 mg/L	20/20	NA	1/1	2/2	NA	NA	23/23	NA
		Anions (Cl/SO4)/ EPA300.0	IC-Conductivity/ 0.2/2mg/L	20/20	NA	1/0	2/2	NA	NA	23/22	80% - 120% +/- 20%
		Alkalinity/ SM2320	Titrimetric/ 5 mg/L	20/20	NA	1/0	2/2	NA	NA	23/22	75% - 125% +/- 35%
		Perchlorate/ EPA 314.0	IC-Conductivity/ 5 ug/L	20/20	NA	1/0	2/2	NA	NA	23/22	75% - 125% +/- 35%
		Cyanide/ EPA 335.3	Colorimetric Autoanalyzer/ 0.005 mg/L	20/20	NA	1/0	2/2	NA	NA	23/22	90% - 110% +/- 20%
		Nitrite/Nitrate as Nitrogen/ EPA 353.2	Colorimetric Autoanalyzer/ 0.05 mg/L	20/20	NA	1/0	2/2	NA	NA	23/22	80% - 120% +/- 20%
		Sulfide/ EPA 376.1	Titrimetric/ 1 mg/L	20/20	NA	1/1	2/2	NA	NA	23/23	75% - 125% +/- 35%
		Organic Carbon/ EPA 415.1	Combustion/IR/ 0.5 mg/L	20/40	NA	1/4	2/4	NA	NA	23/48	70% - 130% +/- 20%

Table 3—QA/QC Analytical Summary and Fixed Laboratory Analytical Methods
Omega Chemical RI/FS
Whittier, California

Laboratory	Matrix	Parameters/ Method	Method Description/ Detection Limits	Total Field Samples[a]/ Containers	QA/QC Sample Summary Analyses/Containers					Total Field and QA/QC Analyses/ Containers[f]	Precision and Accuracy
					Organic MS/MSD[b]	Inorganic MS/Dup[b]	Field Duplicates[c]	Rinsate Blanks[d]	Trip Blanks[e]		

Notes:

[a] Total number of field samples is estimated.

[b] No extra volume is required for soil/sediment or product samples; for water samples, triple volume is required for organic analyses, and double volume is required for inorganic analyses. Sample numbers are based on 1 matrix spike/matrix spike duplicate (MS/MSD) per 20 samples per matrix.

[c] The frequency of field duplicate samples is 10 percent of field samples.

[d] The total number of rinsate samples could vary depending on the total number of samples collected. The sample numbers are based on one rinsate per 20 samples per nondedicated sampling device. Note that rinsate blanks consist of water aliquots for both soil and water field samples.

[e] The total number of trip blanks could vary depending on the total number of sample shipments. This number is based on the estimated number of shipping containers. Note that trip blanks consist of water aliquots for both soil and water field samples.

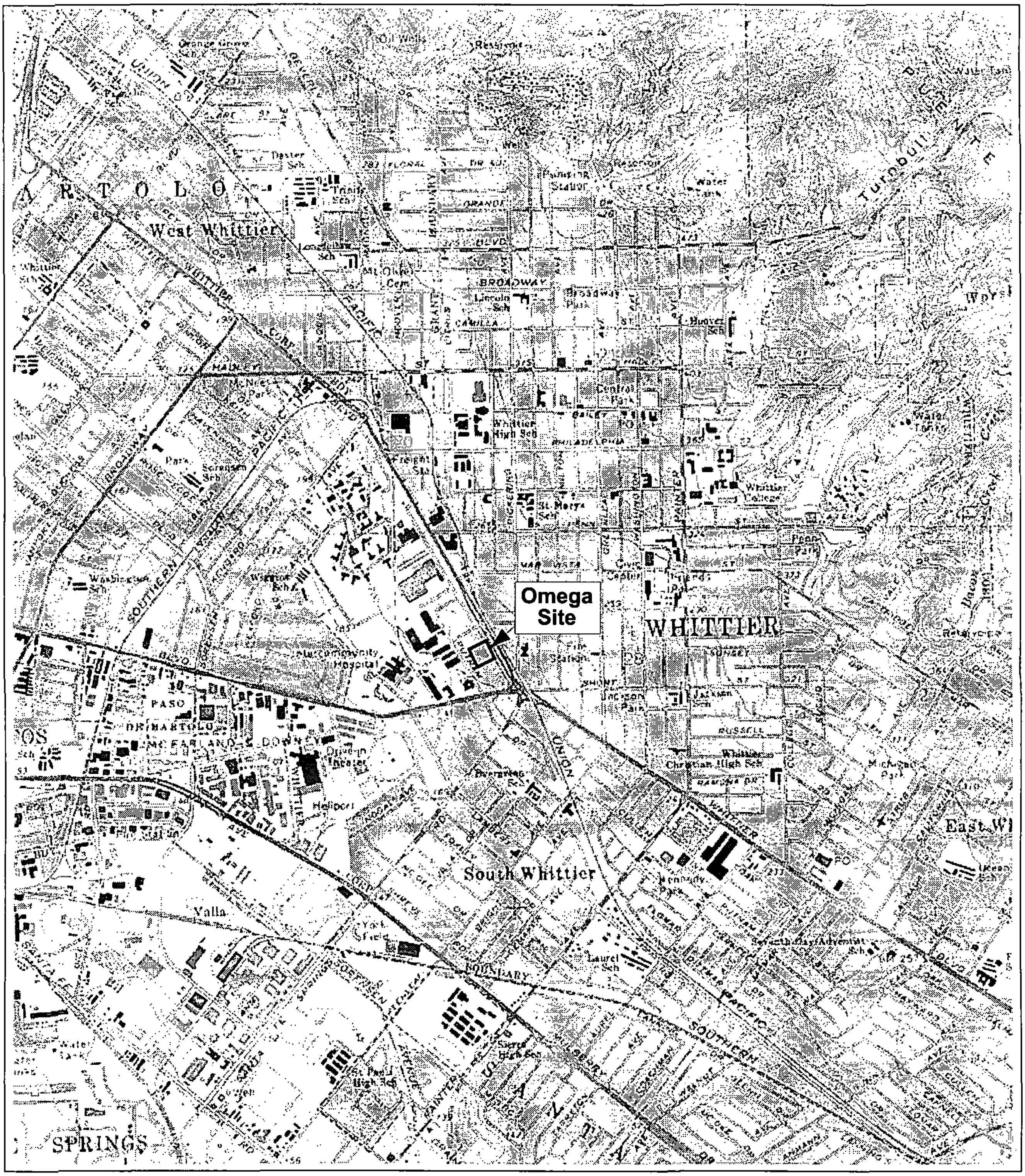
[f] Total analyses and containers includes both field and QA/QC aliquots to be submitted for fixed laboratory analysis. Note that trip blanks and rinsate blanks consist of water aliquots for both soil and water field samples.

AA: Atomic Absorption Furnace Technique.
CLP: Contract Laboratory Program.
CLPAS: Contract-Laboratory Program Analytical Service.
CRDL: Contract-Required Detection Limit.
CRQL: Contract Required Quantitation Limit.
ECD: Electron Capture Detection.
GCS: Gas Chromatographic Separation.
ICP: Inductively Coupled Plasma.
MD: Mass Spectrometric Detection.
MS/MSD: Matrix Spike/Matrix Spike Duplicate.
NA: Not Applicable.
PCBs: Polychlorinated Biphenyls.
Pesticides: Chlorinated Pesticides.
QA: Quality Assurance.
QC: Quality Control.
SVOCs: Semivolatile Organic Compounds.
TAL: Target Analyte List.
VOCs: Volatile Organic Compounds.
TBD : To Be Determined

Table 4 – Headspace VOC Screening Criteria
Omega Chemical RI/FS
Whittier, California

Readings (X)	Ranking
X = Background (BG)	Background
BG < X < 10 units	Low
10 < X < 100	Medium
X > 100	High

Figures

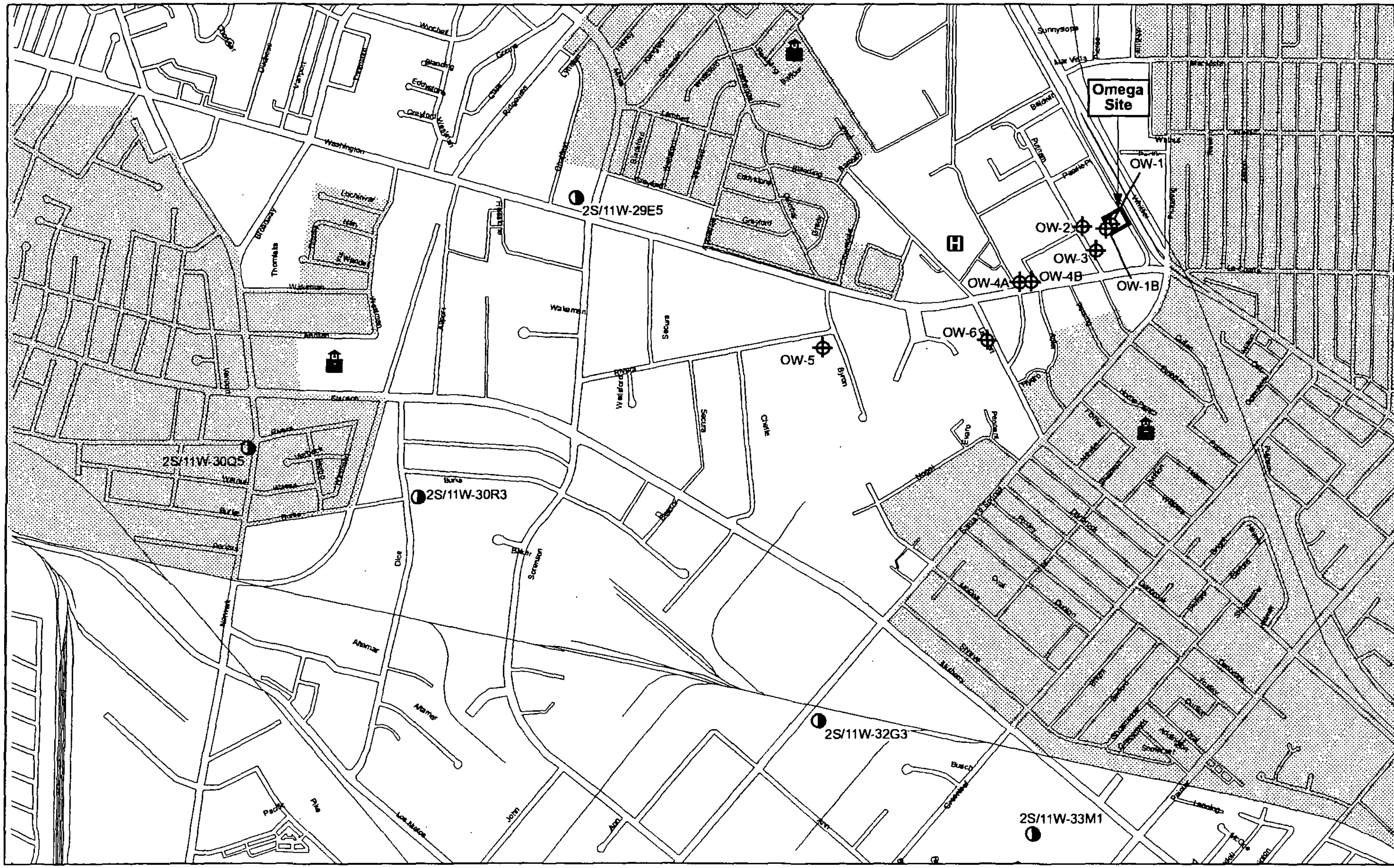


Site Location Map
Omega Superfund Site

WESTON
MANAGERS DESIGNERS/CONSULTANTS

Figure
1-1

01-0179 Fig1-1.ai



N

0 600 1200

Scale in Feet

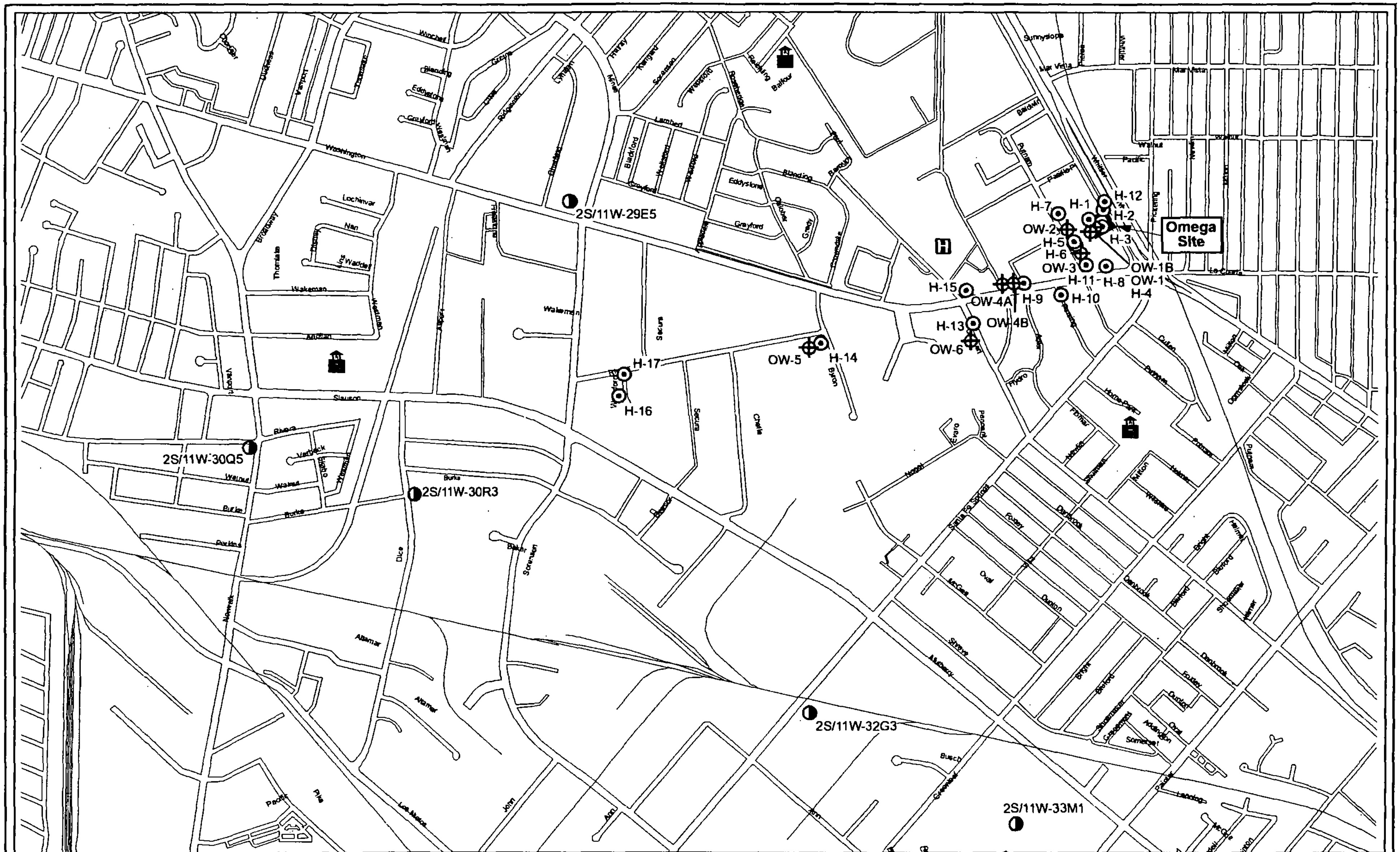
WESTON® MANAGERS DESIGNERS/CONSULTANTS

- Existing Monitoring Wells and Number
- Production Wells and Number
- Omega Site
- Primarily Residential Areas
- Hospital
- *School*

Site Features Map
Omega Superfund Site

Figure
1-2

01-0179 Fig1-2.ai



N

0 600 1200

Scale in Feet

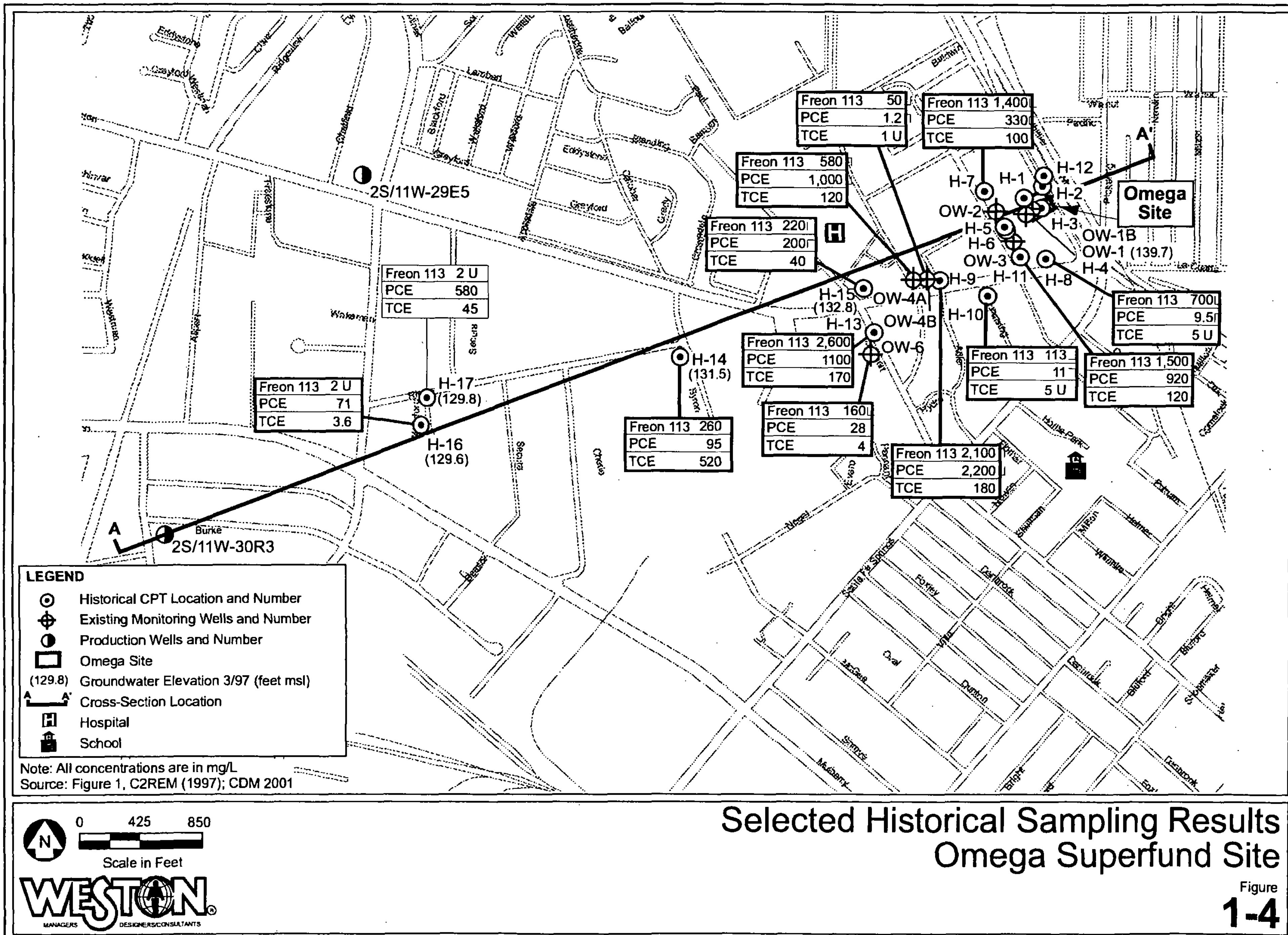
WESTON MANAGERS DESIGNERS/CONSULTANTS

- Historical CPT Location and Number
- Existing Monitoring Wells and Number
- Production Wells and Number
- Omega Site
- Hospital
- School

Historical Groundwater Sampling Locations
Omega Superfund Site

Figure
1-3

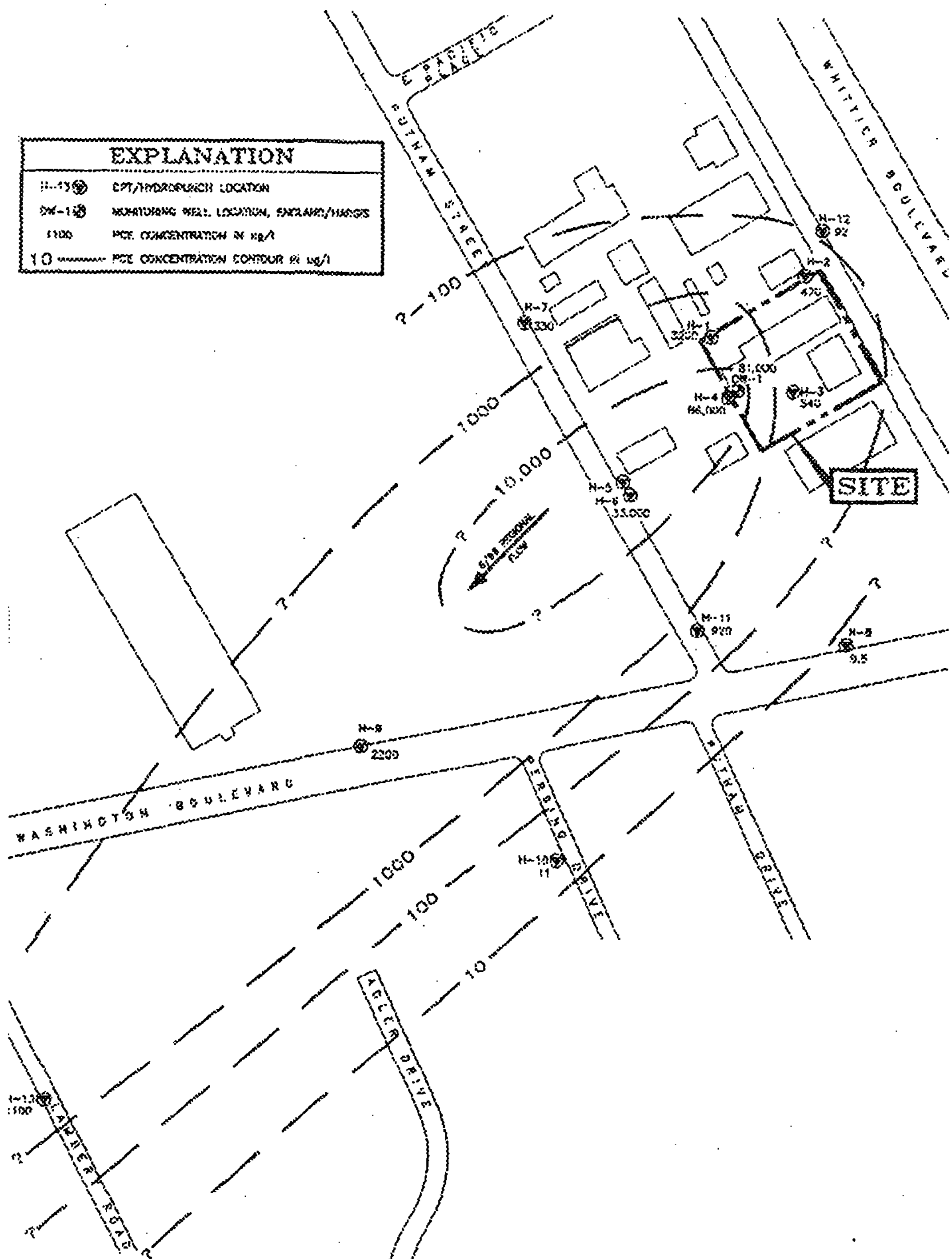
01-0179 Fig1-3.ai



Selected Historical Sampling Results
Omega Superfund Site

Figure
1-4

01-0179 Fig1-4.ai



Source: Case II Close Out Report Volume I, October 1996 (England and Hargis.)

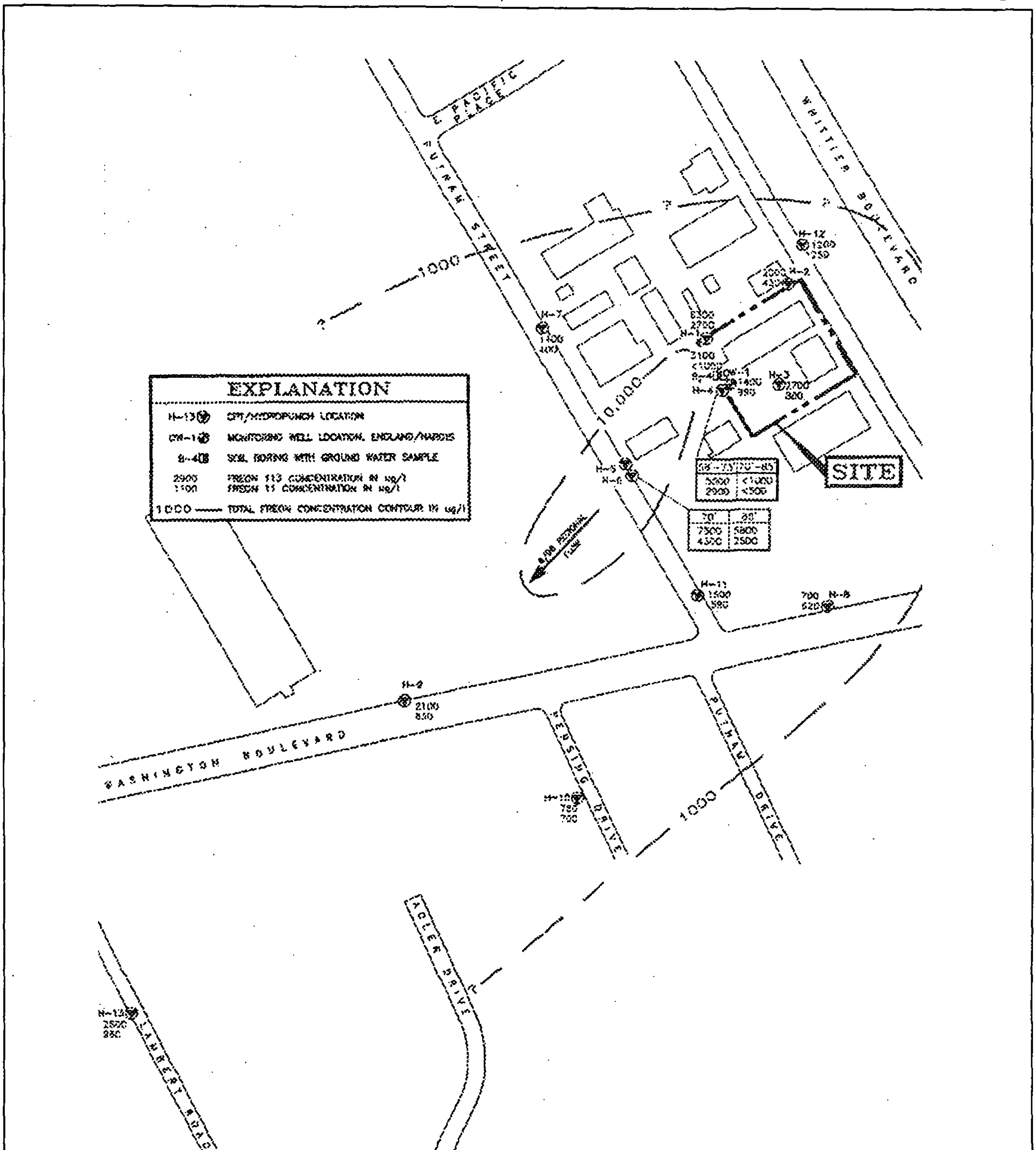
PCE Distribution in Ground Water
Omega Superfund Site

0 100 200
Approximate
Scale in Feet

WESTON
MANAGER DESIGNER/CONSULTANTS

Figure
1-5

01-0179 Fig1-5.ai



Source: Case II Close Out Report Volume I, October 1996 (England and Hargis.)

Total Freon Distribution in Ground Water
Omega Superfund Site

0 100 200
Approximate
Scale in Feet

WESTON
MANAGER DESIGNER /CONSULTANTS

Figure
1-6

01-0179 Fig1-6.ai

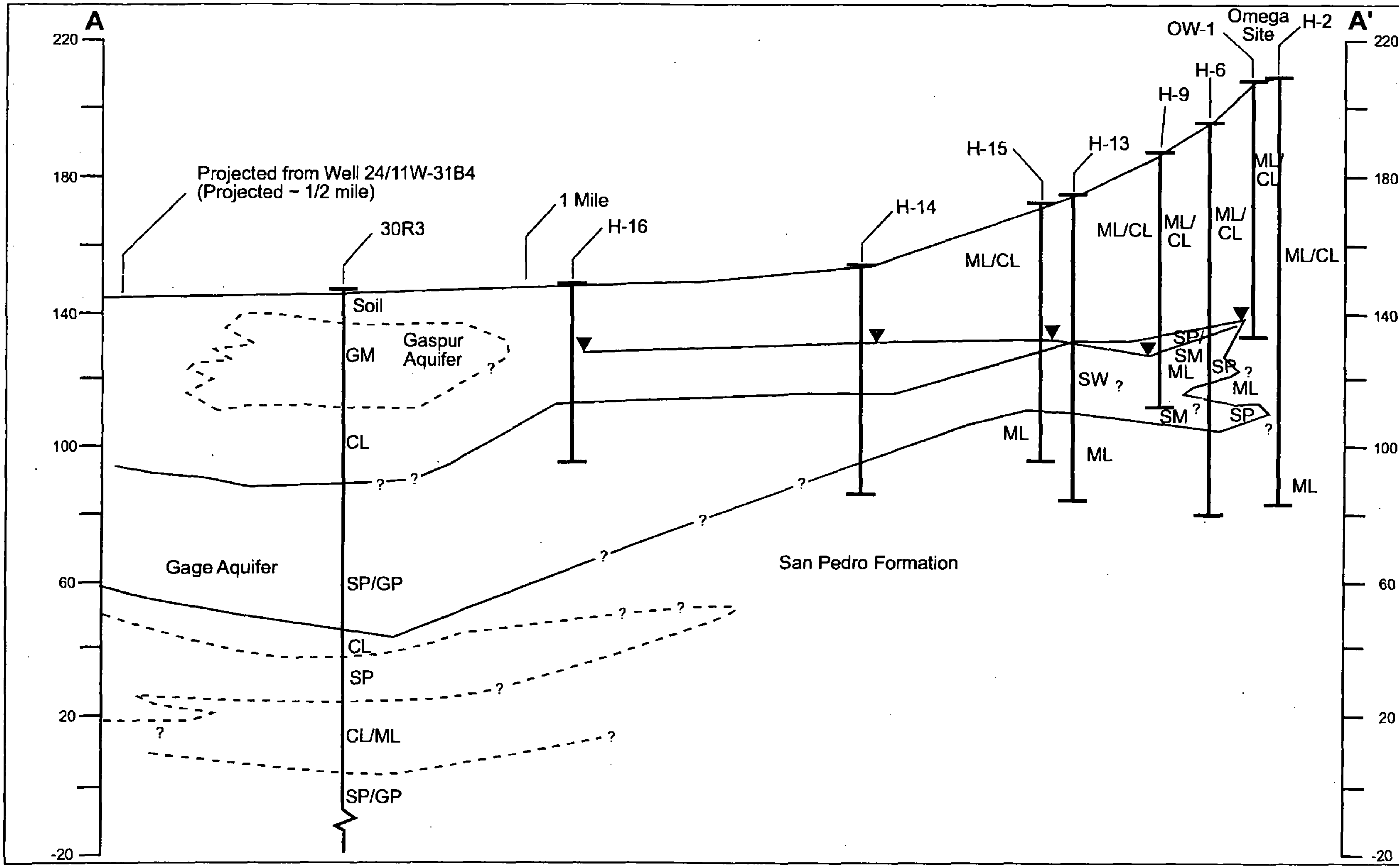
System	Series	Formation	Aquifer and Aquiclude	Thickness (feet)
QUATERNARY	RECENT	ALLUVIUM	BELLFLOWER AQUICLUDE	10-40
			GASPUR	0-30
	UPPER PLEISTOCENE	LAKEWOOD FORMATION	BELLFLOWER AQUICLUDE	10-40
			ARTESIA	0-40
			GAGE	0-30
		UNCONFORMITY		
	LOWER PLEISTOCENE	SAN PEDRO FORMATION	HOLLYDALE	0-40
			JEFFERSON	20-40
			LYNWOOD	50-100
			SILVERADO	100-300
			SUNNYSIDE	200-300
		LOCAL	UNCONFORMITY	
TERTIARY	UPPER PLIOCENE	PICO FORMATION	UNDIFFERENTIATED	

Generalized Stratigraphic Column
Whittier Area (Based on data from CDW 1961)
Omega Superfund Site

WESTON. MANAGER DESIGNER CONSULTANTS

Figure **1-7**

01-0179 Fig1-7.ai

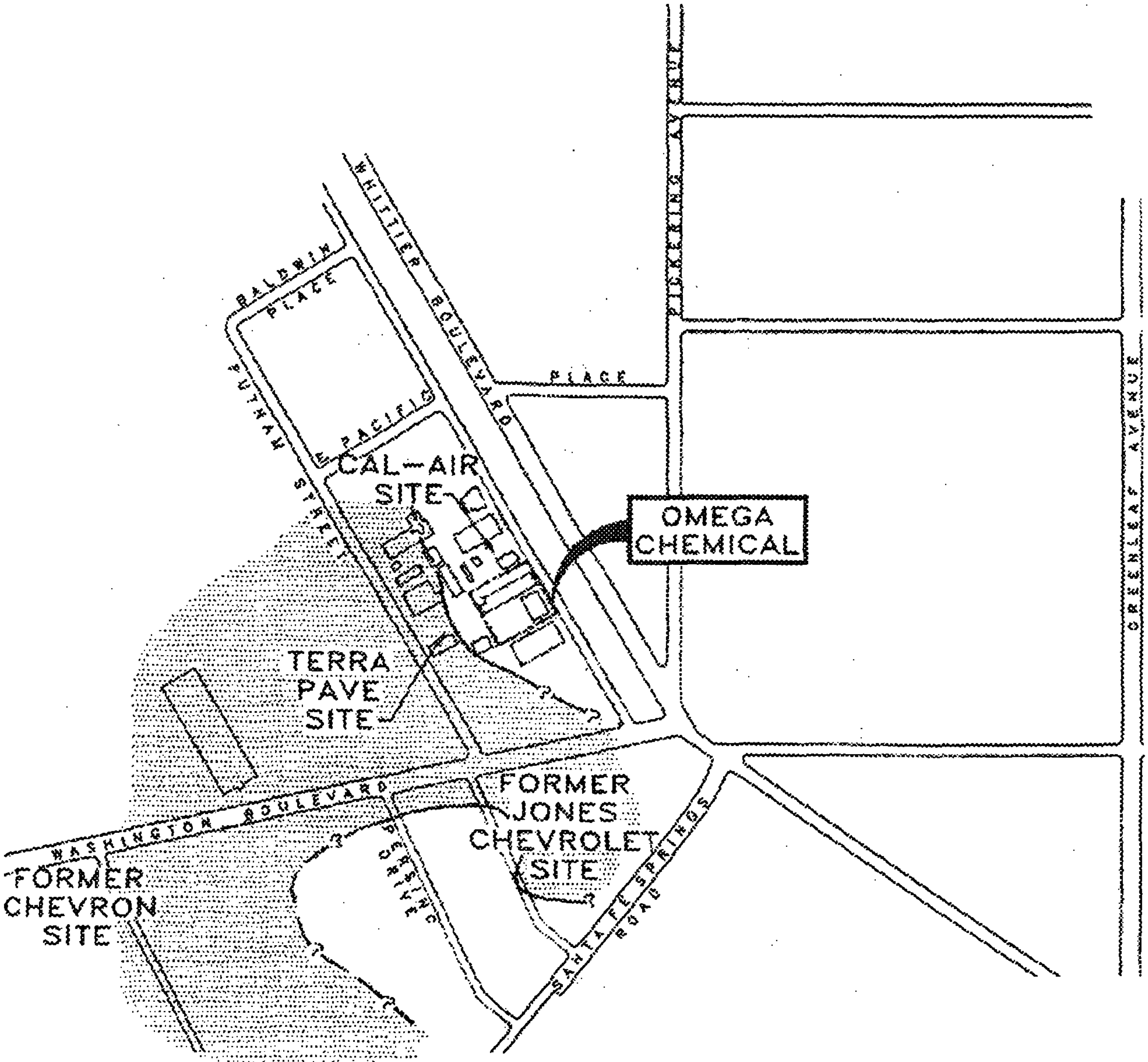


Source: Figure 2, C2REM (1997)

Local Cross-Section A-A'
Omega Superfund Site

Figure
1-8

01-0179 Fig1-8.ai



EXPLANATION

Sand Unit Encountered in Soil Borings

Source: Case II Close Out Report Volume I, October 1996 (England and Hargis.)

Presence of Sandy Unit in Subsurface
Omega Superfund Site

0 225 450

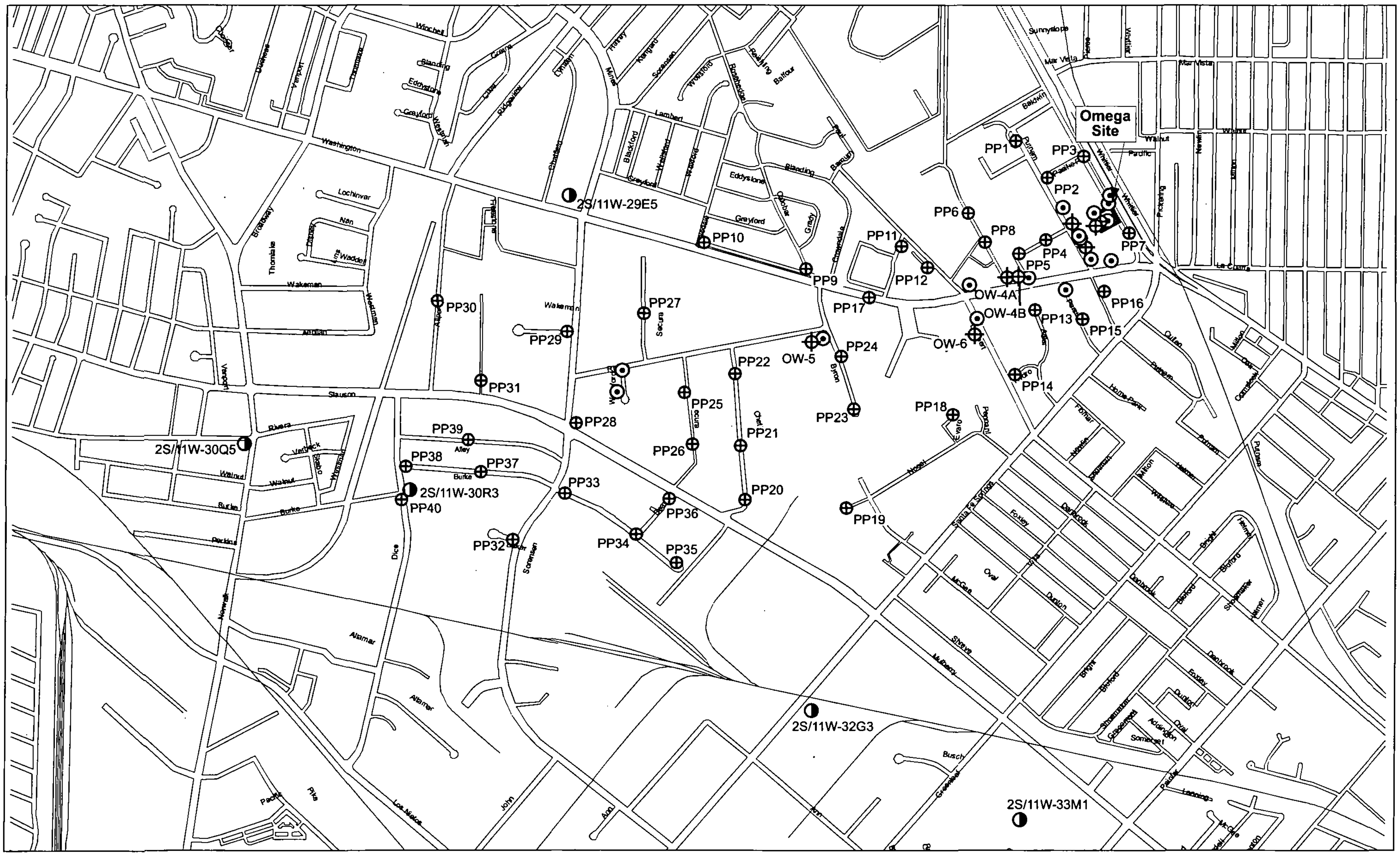
Approximate Scale in Feet

WESTON. MANAGER DESIGNER CONSULTANTS

Figure

1-9

01-0179 Fig1-9.ai



N

0 600 1200

Scale in Feet

WESTON
MANAGERS DESIGNERS/CONSULTANTS

- Historical CPT Location and Number
- Existing Monitoring Wells and Number
- Production Wells and Number
- Proposed CPT Location and Number
- Omega Site

Proposed Groundwater Sampling Locations
Omega Superfund Site

Figure
3-1

01-0179 Fig3-1.ai

Appendix A

SOP Number: RFW/R10-009, Revision 0
Document Control Number: 12644-001-002-AABH

STANDARD OPERATING PROCEDURE FOR LOW-FLOW GROUNDWATER SAMPLING

Prepared by:

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31 May 2001

APPROVALS

Reviewed by: ____________________ Date: June 1, 2001
Site Assessment Project Manager

Approved by: ____________________ Date: 06/01/2001
Quality Assurance Officer

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1.0 Scope and Applicability

The purpose of this standard operating procedure (SOP) is to describe the procedures that Roy F. Weston, Inc. (WESTON®) sampling personnel will use for collecting groundwater samples using the low-flow (low stress) method. The purpose for the collection and analysis of groundwater samples is described in the body of the Field Sampling Plan (FSP) and may include determining if concentrations of hazardous substances in groundwater exceed established action levels, confirming or identifying hazardous substances that may have impacted the environment, or determining if the concentrations of hazardous substances may present a risk to public health, welfare, or the environment.

2.0 Summary of Method

Groundwater samples collected by the low-flow method are indicative of mobile organic and inorganic substances (total and dissolved) at ambient flow conditions. This SOP emphasizes the need to minimize stress via low water-level drawdowns, and low pumping rates (usually less than 0.5 liter/minute) in order to collect samples with minimal alterations to water chemistry. This SOP is aimed at collecting samples from monitoring wells having a screen or open interval length of 10 feet or less by utilizing a submersible or peristaltic pump. However, this procedure is flexible and can be used in a variety of well construction and groundwater yield situations. Samples thus obtained are suitable for analyses of groundwater contaminants [volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), pesticides/polychlorinated biphenyls (pest/PCBs), metals, cyanide, and other inorganics], or other naturally occurring analytes. This procedure does not address the collection of samples from wells containing light or dense non-aqueous phase liquids (LNAPLs and/or DNAPLs). Basic procedures are described herein and summarized in the attachment to this SOP.

3.0 Acronym List

cc	-	Cubic centimeters
CLP	-	Contract Laboratory Program
COC	-	Chain-of-custody
°C	-	Degrees Celsius
DAS	-	Delivery of Analytical Services
DNAPL	-	Dense non-aqueous phase liquids
DO	-	Dissolved oxygen
DOT	-	Department of Transportation
Dup	-	Duplicate
EPA	-	U.S. Environmental Protection Agency
ft	-	Feet
FID	-	Flame ionization detector
FSP	-	Field Sampling Plan
GPS	-	Global Positioning System
HASP	-	Health and Safety Plan
HCl	-	Hydrochloric Acid

HNO_3	-	Nitric Acid
IATA	-	International Air Transport Association
LNAPL	-	Light non-aqueous phase liquids
ml	-	Milliliter
MS/MSD	-	Matrix Spike/Matrix Spike Duplicate
NaOH	-	Sodium Hydroxide
NTU	-	Nephelometric Turbidity Unit
ORP	-	Oxidation reduction potential
OSHA	-	Occupational Safety and Health Administration
Pest/PCB	-	Pesticide/Polychlorinated Biphenyl
PE	-	Performance evaluation
PID	-	Photoionization detector
PPE	-	Personal Protective Equipment
ppm	-	Parts per million
PRP	-	Potentially Responsible Party
QAPP	-	Quality Assurance Project Plan
QA/QC	-	Quality Assurance/Quality Control
RFP	-	Request for Proposal
SDG	-	Sample Delivery Group
SOP	-	Standard Operating Procedure
SAP	-	Sampling Analysis Plan
START	-	Superfund Technical Assessment and Response Team
SVOC	-	Semivolatile Organic Compound
TDD	-	Technical Direction Document
TWP	-	Task Work Plan
μm	-	Micrometers
VOC	-	Volatile Organic Compound
WESTON	-	Roy F. Weston, Inc.
YSI Meter	-	Multi-Parameter Flow-Through Monitoring System Meter

4.0 Health and Safety Warnings

Personnel performing work on hazardous waste sites will follow Occupational Safety and Health Administration (OSHA), California-OSHA, and U.S. Environmental Protection Agency (EPA), and health and safety procedures and protocols. Personnel conducting on-site low-flow groundwater sampling activities will also perform tasks in accordance with the EPA-approved, site-specific Sampling and Analysis Plan (SAP), which incorporates the FSP and Quality Assurance Project Plan (QAPP).

In order to ensure the safety of personnel during sampling activities, the buddy system, periodic air monitoring (if deemed necessary in the site-specific HASP), and caution will be used throughout field activities. To minimize risks due to chemical exposure, dermal and respiratory protection may be required if air monitoring (as per the site-specific HASP) or other criteria indicate that the environment is unsafe. Field activities will follow the site health and safety plan (HASP), which further addresses the safety considerations of the property. Hazards identified in or around the site may include physical hazards (slips, trips, and falls). Additional potential hazards exist in association with the use of electrical generators; therefore, the sampling team will follow industry standards and protocols for all activities involving electrical devices.

5.0 Interferences

The primary goal of low-flow groundwater sampling is to obtain a representative sample of the groundwater at ambient flow conditions. Analysis can be compromised by field personnel in two primary ways: collecting a non-representative sample or cross-contamination of the sample.

When collecting groundwater samples using the low-flow method, stabilization of indicator field parameters is used to indicate that conditions are suitable for sampling to begin. A non-representative sample can result from the collection of a sample prior to the stabilization of indicator field parameters. Cross-contamination of the sample can be eliminated or minimized through the use of dedicated sampling equipment. If this is not possible or practical, then decontamination of sampling equipment is necessary.

6.0 Personnel Qualifications

Only qualified personnel will conduct low-flow groundwater sampling. Training of sampling team members will be provided to ensure that technical, operational, and quality requirements are understood. Personnel are trained in-house to conduct low-flow groundwater sampling activities. Training includes reviewing this SOP and other applicable SOPs and/or guidance documents, instrument calibration training, health and safety training, and "hands-on" experience conducting groundwater sampling activities with more experienced personnel.

7.0 Apparatus and Materials

Equipment and materials used for collecting groundwater samples using the low-flow method include, but are not limited to, the following:

- Site-specific SAP
- SOP for Low-Flow Groundwater Sampling
- Safety equipment specified in the site-specific HASP
- Field map of the site
- Monitoring well construction information (if available)
- Field logbook
- Field data sheets (for recording groundwater parameters)
- Tape measure
- Compass
- Camera and film
- Calculator
- Stop watch

- Barometer
- Keys for well cap locks
- Photoionization Detector (PID) or Flame Ionization Detector (FID) (if specified in the site-specific HASP)
- YSI 6-Series Multi-Parameter Flow-Through Monitoring System Meter (or similar instrument)
- Calibration fluids for YSI Meter
- Turbidity meter
- Calibration kit for turbidity meter
- Water level indicator
- Submersible pump (if applicable)
- Peristaltic pump (if applicable)
- Generator
- Extension cords
- Polyethylene tubing
- Tygon tubing
- Peristaltic tubing
- In line filters
- Graduated cylinder (1 to 2 liters preferably)
- Plastic beakers (1 liter)
- Three way valves
- 5-Gallon buckets
- Decontamination fluids (supplies)/equipment (pump sprayers, brushes, etc.)
- Plastic sheeting
- Plastic tubs
- Sample containers
- pH paper
- Chain-of-custody (COC) forms and seals
- Re-sealable plastic bags
- Labels
- Trash bags
- Coolers and ice
- Vermiculite
- Tape (duct, packing, and strapping)

7.1 Reagents

Reagents used for the preservation of groundwater samples may include hydrochloric acid, nitric acid, and sodium hydroxide. Sampling preservation methods are further discussed in *Section 10.0, Sample Containers, Preservation, Handling, and Storage*.

8.0 Method Calibration

The following instructions are specific for use of the YSI 6-Series Multi-Parameter Flow-Through Monitoring System Meter (YSI Meter).

8.1 YSI Meter Set up

Remove the YSI Meter (sonde, flow-through cell, storage cup, hand-held field display, and stand) from the carrying case. Check all probes on the sonde to make sure they are intact. Check to ensure that the clear membrane covering the dissolved oxygen (DO) probe is not damaged and that no air is leaking into the system. Replace the membrane if damaged. Instructions for replacing the membrane are discussed in *Section 8.2, Replacing the DO Probe Membrane*. If all probes are intact, attach the sonde to the reel. Plug the hand-held field display into the sonde and begin calibration. Instructions for calibration of the YSI Meter are detailed in *Section 8.3, Calibrating the YSI Meter*.

After calibration of the YSI Meter is completed, attach the flow-through cell to the sonde. Attach tygon tubing to the intake and outtake ports on the flow-through cell. Groundwater is pumped from the monitoring well and flows through tubing into the intake port (located at the bottom of the flow-through cell), into the flow-through cell, and out through the outtake port (located at the top of the flow-through cell). The flow-through cell should not contain any air bubbles once it is filled with water.

8.2 Replacing the DO Probe Membrane

If the membrane covering the DO probe is damaged, replace the membrane. A membrane replacement kit is included with the YSI Meter. The membrane can be replaced as follows:

- Remove the damaged membrane from the DO probe body.
- Prepare the potassium chloride electrolyte solution included in the kit. Dissolve the potassium chloride in the dropper bottle by filling it to the neck with deionized water and mixing it without shaking it until the solids are fully dissolved.
- Hold the sonde upside down in a vertical position. Apply a few drops of potassium chloride solution to the probe. The fluid should completely fill the small moat around the electrodes and form a convex meniscus on the tip of the sensor. No air bubbles should be present on the surface of the probe.
- Without touching the membrane surface to cover the probe, stretch a new membrane over the probe body and secure it with an O-ring. Make sure the membrane is pulled tightly and no air bubbles are trapped. If air bubbles are

present, repeat the preceding step. Trim the membrane to approximately 1/8 inch from the O-ring.

8.3 Calibrating the YSI Meter

Once the sonde is attached to the reel and is hooked up to the hand-held display, the instrument is ready to be calibrated. Press **POWER** on the hand-held display. This will bring up the Main Menu display. Press **ESC** and then highlight Calibration Mode (using the arrow buttons) and press **ENTER**. This brings up a list of the several parameters including pH, specific conductivity, oxidation reduction potential (ORP), and DO to be calibrated. At this time, record the batch number and expiration dates of all calibration standard solutions used during calibration. [Note: Thoroughly rinse the probes with deionized water between all calibrations].

8.3.1 Dissolved Oxygen (DO)

Calibration of DO requires a barometric pressure reading at the time of the sampling. A barometer should be available; however if it is unavailable, a default reading of 760 milliliters (ml) of mercury can be used. Thread the storage cup (with a damp piece of sponge in the bottom) loosely around the probes. Highlight DO and press **ENTER**. Highlight percent (%) and press **ENTER**. Enter 100% and press **ENTER**. Enter the appropriate barometric pressure (or 760 milliliters of mercury) and press **ENTER**. Once the DO stabilizes at (or around) 100%, record the DO value, and press **ENTER**. At this time, a message should appear indicating that calibration is successful. If a message indicating that calibration was unsuccessful appears, repeat the calibration until it is successful. Press **ESC** to return to the Main Menu screen.

8.3.2 Specific Conductivity

Highlight Specific Conductivity and press **ENTER**. Highlight 1 millisiemen (Note: the calibration standard solution is labeled as 1,000 <u>micro</u>siemens), submerge all probes in the specific conductivity 1 millisiemen calibration standard solution, and press **ENTER**. Once the specific conductivity stabilizes at (or around) 1,000 <u>micro</u>siemens, record the specific conductivity value, and press **ENTER**. At this time, a message should appear indicating that calibration was successful. If a message indicating that calibration was unsuccessful appears, repeat the calibration until it is successful. Press **ESC** to return to the screen listing the four parameters.

[Note: If during calibration, the specific conductivity value changes at four second intervals, the DO membrane is damaged and must be replaced. Instructions for replacing the membrane are discussed in *Section 8.2, Replacing the DO Probe Membrane*].

8.3.3 pH (4 and 7)

From the parameter screen, highlight pH (using the arrow buttons), press **ENTER**, and then highlight 2-Point Calibration (4 and 7) and press **ENTER**. Two pH levels (4 and 7) will be available. Highlight pH 4, submerge all probes into the pH 4 calibration standard solution, and press **ENTER**. Once the pH stabilizes at (or around) 4, record the pH value, and press **ENTER**. At this time, a message should appear indicating that calibration was successful. If a message indicating that calibration was unsuccessful appears, repeat the calibration until it is successful. Press **ESC** to return to the screen to choose which pH level to calibrate. Repeat the above steps for pH 7 using the appropriate calibration standard solution. After the pH calibration is complete, press **ESC** to return to the screen listing the four parameters. You can do a 3-Point Calibration with 4, 7 and 10 pH solutions if desired following the same procedures described above, depending upon pH range of field samples.

8.3.4 Oxidation Reduction Potential (ORP)

Calibration of ORP requires a temperature reading at the time of the sampling. To obtain a temperature reading, press **ESC** on the hand held-held display until you reach Run Mode. Press **ENTER** and record the current temperature. Refer to the temperature/ORP guide included with the YSI Meter to determine the appropriate ORP reading for the temperature. Press **ESC** to return to the Main Menu. Press **ESC** and then highlight calibration mode and press **ENTER** which will bring up the screen listing the four parameters. Highlight ORP, and press **ENTER**. Enter the appropriate ORP value (obtained from the temperature/ORP guide), submerge the ORP and temperature probes in the ORP calibration standard solution, and press **ENTER**. Once the ORP stabilizes at (or around) its specified value, record the ORP value, and press **ENTER**. At this time, a message should appear indicating that calibration was successful. If a message indicating that calibration was unsuccessful appears, repeat the calibration until it is successful. Press **ESC** to return to the screen listing the four parameters.

The YSI meter will be calibrated twice a day: after field personnel have arrived on site (prior to sampling) and prior to field personnel departing the site (after sampling).

9.0 Sample Collection

9.1 Preparation

Following EPA approval of the site-specific SAP and prior to conducting sampling activities, a pre-sampling meeting will be held by sampling team members to discuss the proposed sampling strategy and site health and safety issues. Attendees of the pre-sampling meeting will include the Project Manager, Site Leader, samplers, and the project Health and Safety Officer. During the pre-sampling meeting, the Site Leader discusses the site history, contaminants of concern, sampling methodology, individual responsibilities, sample shipment or delivery, health and safety issues, and lines of communication anticipated during the sampling event.

Prior to mobilizing to the site to conduct sampling activities, the Site Leader will fill out an equipment/supply list and transmit the list to the WESTON Equipment Stores or technician one week prior to the sampling event. Necessary sampling equipment, sample containers, personnel protective equipment (PPE), and vehicles are therefore reserved.

In addition, Contract Laboratory Program (CLP) and/or Delivery of Analytical Services (DAS) laboratories are secured or procured one week prior to the sampling event.

9.2 Low-Flow Groundwater Sampling

Prior to conducting any on-site activities, sampling team members will review and sign the site-specific HASP. The field team will establish a command post upwind of suspected source areas, if possible. Team members will perform calibration checks of air monitoring instruments if these are specified in the HASP and document background ambient air monitoring levels. Team members will calibrate the YSI Meter and other water quality monitoring instruments. The samplers will decontaminate the sampling equipment (if appropriate). Decontamination will be conducted in accordance with the HASP and/or applicable SOPs. Decontamination generally consists of an alconox and water wash followed by a water rinse, followed by an isopropanol rinse, followed by a deionized water final rinse, and air drying. Equipment decontamination fluids, purge water from monitoring wells, and PPE generated during sampling activities will be containerized and disposed appropriately based on the results of laboratory analyses of samples collected.

The number of groundwater samples and the sample locations are described in the approved site-specific SAP. Under the Removal Program, groundwater samples are generally collected to determine if hazardous substances have migrated from on-site sources to the groundwater, and have migrated off site and potentially impacted private and public supply wells. Under the Site Assessment Program, groundwater samples are generally collected to evaluate the groundwater pathway and determine if hazardous substances attributable to on-site sources have migrated off site and have potentially impacted private wells and public wells. Groundwater and drinking water samples are also used to identify Level I and/or Level II targets under the Hazard Ranking System.

9.2.1. Preliminary Well Observations

Prior to sampling a monitoring well, personnel will check the well for security damage or evidence of tampering, and will record pertinent observations. Personnel will remove the well cap and will immediately screen the headspace of the well for VOCs with a PID or FID, and record the reading in the field logbook if specified in the HASP. If the well casing does not have a reference point (usually a V-cut or indelible mark in the well casing), personnel will make one and record the location and date of the mark in the logbook. The reference point will typically be placed on the north side of the well casing.

A synoptic water level measurement round should be performed (in the shortest possible time) before any sampling activities begin. All measurements must be taken from the established referenced point. Care should be taken to minimize water column disturbance. Total depth sounding will be deferred until after sampling at each well to mitigate potential disturbance of accumulated sediment in the well bottom.

Proper well construction and development cannot be overemphasized, since the use of installation techniques that are appropriate to the hydrogeologic setting often prevents "problem well" situations from occurring. The screen, or open interval of the monitoring well should be optimally located (both laterally and vertically) to intercept existing contaminant plume(s) or along flowpaths of potential contaminant releases. It is presumed that the analytes of interest move (or potentially move) primarily through the more permeable zones within the screen, or open interval. It is also recommended that as part of development, or redevelopment, the well should be tested to determine the appropriate pumping rate to obtain stabilization of field indicator parameters with minimal drawdown in the shortest amount of time. With this information, field crews can then conduct purging and sampling in a more expeditious manner.

The mid-point of the saturated screen length (which should not exceed 10 feet) is used by convention as the location of the pump (or tubing) intake. However, significant chemical or permeability contrast(s) within the screen may require additional field work to determine the optimum vertical location(s) for the intake, and appropriate pumping rate(s) for purging and sampling more localized target zone(s). Primary flow zones (high(er) permeability and/or high(er) chemical concentrations) should be identified in wells with screen lengths longer than 10 feet, or in wells with open boreholes in bedrock. Targeting these zones for water sampling will help ensure that the low-flow method will not underestimate contaminant concentrations. The SAP must provide clear instructions on how the pump intake depth(s) will be selected, and reason(s) for the depth(s) selected.

Newly constructed wells will be checked for the presence of LNAPLs or DNAPLs before the initial sampling round. If none are encountered, subsequent measurements with an interface probe are usually not needed unless analytical data or field headspace information signal a worsening situation. [Note: procedures for collection of LNAPL and DNAPL samples are not addressed in this SOP].

9.2.2. Purging Procedures

Wells with low recharge rates may require the use of special pumps capable of attaining very low pumping rates (peristaltic), and/or the use of dedicated sampling equipment such as submersible electric or bladder pumps.

Lower the submersible pump or tubing (when using a peristaltic pump) slowly (to minimize disturbance) into the well to the midpoint of the zone to be sampled. Criteria for the selection of the midpoint for each well are described in Section 9.2.1. If possible, keep the pump intake or tubing at least 2 feet above the bottom of the well, to minimize mobilization of particulates present in the bottom of the well.

Prior to starting the submersible pump or peristaltic pump, measure the water level in the well. If possible, leave the water level meter in the well while purging in order to more effectively determine drawdown of the water column.

Start the pump at its lowest speed setting and slowly increase the speed until discharge occurs. Check the water level and adjust the pump speed until there is little or no water level drawdown (less than 0.3 feet). If the minimal drawdown that can be achieved exceeds 0.3 feet but remains stable, continue purging until indicator field parameters stabilize. Monitor and record water level and pumping rate every 5 minutes (or as appropriate) during purging. Record any pumping rate adjustments (both time and flow rate). Pumping rates should, as needed, be reduced to the minimum capabilities of the pump (e.g., 0.1 to 0.4 liter/minute) to ensure stabilization of indicator parameters. Adjustments are best made in the first 15 minutes of pumping in order to help minimize purging time. During pump start-up, drawdown may exceed the 0.3 feet target and then "recover" as pump flow adjustments are made.

Do not allow the water level to fall to the intake level (further, if the static water level is above the well screen, avoid lowering the water level into the screen).

9.2.3. Monitoring Parameters

All parameter measurements, except turbidity, must be obtained using a flow-through-cell. Transparent flow-through-cells will be used because they allow field personnel to watch for particulate build-up within the cell. This build-up may affect indicator field parameter values measured within the cell and may also cause an underestimation of turbidity values measured after the cell. If the cell needs to be cleaned during purging operations, continue pumping and disconnect cell for cleaning, then reconnect after cleaning and continue monitoring activities.

The flow-through-cell must be designed in a way that prevents air bubble entrapment in the cell. When the pump is turned off, water in the cell must not drain out.

Monitoring probes must be submerged in water at all times. If two flow-through-cells are used in series, the one containing the DO probe should come first (this parameter is most susceptible to error if air leaks into the system).

During well purging, monitor indicator field parameters (turbidity, temperature, pH specific conductance, ORP, and DO) every 3 minutes (or less frequently, if appropriate). [Note: During the early phase of purging, emphasis should be put on minimizing and stabilizing pumping stress, and recording those adjustments]. Purging is considered complete and sampling may begin when all the above indicator field parameters have stabilized. Stabilization is considered to be achieved when three consecutive readings, taken at 3-minute intervals, are within the following limits:

- pH (± 0.1 unit).
- Specific conductance (3%).
- DO (10%).

Stabilization of indicator field parameters is used to indicate that conditions are suitable for sampling to begin. Achievement of turbidity levels of less than 5 Nephelometric Turbidity Units (NTU) and stable drawdowns of less than 0.3 feet, while desirable, are not mandatory. Sample collection may still take place provided the remaining criteria in this procedure are met. If after 0.5 hours of purging, indicator field parameters have not stabilized, one of three optional courses of action may be taken:

- Continue purging until stabilization is achieved.

- Discontinue purging, do not collect any samples, and record in the logbook that stabilization could not be achieved (documentation must describe attempts to achieve stabilization).

- Discontinue purging, collect samples, and provide full explanation of attempts to achieve stabilization. (Note: There is a risk that the analytical data obtained, especially for metals and strongly hydrophobic organic analytes, may not meet the sampling objectives).

If the recharge rate of the well is lower than extraction rate capabilities of currently manufactured pumps and the well is essentially dewatered during purging, then the well should be sampled as soon as the water level has recovered sufficiently to collect the appropriate volume needed for all anticipated samples (ideally the intake should not be moved during this recovery period). Samples may then be collected even though the indicator field parameters have not stabilized.

9.2.4. Collection of Samples

During purging and sampling, the tubing should remain filled with water so as to minimize possible changes in water chemistry due to contact with the atmosphere. It is recommended that 1/4-inch or 3/8-inch (inside diameter) tubing be used to help ensure that the sample tubing remains filled with water. Larger diameter discharge tubing (e.g. ½-inch inside diameter) may be used if sufficient water is present to ensure tubing remains completely filled. If the pump tubing is not completely filled to the sampling point, use one of the following procedures to collect samples:

- Add clamp, connector (Teflon or stainless steel) or valve to constrict sampling end of tubing.
- Insert small diameter Teflon tubing into water-filled portion of pump tubing, allowing the end to protrude beyond the end of the pump tubing, and collect sample from small diameter tubing.
- Increase the flow rate slightly until the water completely fills the tubing; collect sample and record new drawdown, flow rate, and new indicator field parameter values.

Groundwater samples for laboratory analyses must be collected before the water has passed through the flow-through-cell (e.g., use a three-way valve prior to the flow-through-cell). The VOC samples will be collected first, followed by SVOCs, metals, and cyanide samples.

The collection of VOC samples requires minimal disturbance of the sample to limit volatilization and therefore a loss of volatiles from the sample. The following procedures must be followed while collecting the VOC fraction of the sample.

- Open the vial, set the cap in a clean place, and collect the sample by allowing the water to flow gently down the inside of the container with minimal disturbance of the sample to limit volatilization and therefore prevent loss of volatile compounds from the sample. VOC samples shall not be collected and/or preserved near a running motor or any type of exhaust system due to possible contamination by discharges, fumes or vapors. Each container will be preserved with two (2) drops of 1:1 hydrochloric acid (HCl) per 40 ml of sample so that the pH is < 2. To collect a sample, open the container, set the cap in a clean place, and collect the sample. When collecting replicate VOC samples, collect both samples at the same time. Fill the container to just overflowing until there is a convex meniscus on the top of the container. Check that the cap has not been contaminated (splashed) and carefully cap the container. Place the cap directly over the top and screw down firmly. Do not overtighten and break the cap. The sealed container will be inverted, tapped gently on the side, and observed for 10 seconds for the presence of air bubbles. If an air bubble appears, the collection procedure should be repeated. The sample containers will then be shaken vigorously to mix the preservative; placed in a resealable plastic bag; and placed into a cooler with ice. The holding time for preserved VOC samples is 14 days. Samples should be shipped or delivered to the laboratory daily so as not to exceed the holding time. Ensure that the samples remain at 4 degrees celsius (°C), but do not allow them to freeze.

One trip blank sample (organic-free water) will be collected prior to sampling on a daily basis or at a rate of one per shipment. Preparation of trip blanks is discussed in *Section 14.3, Trip Blanks.*

<u>SVOC Sampling</u> - Samples will be collected by allowing the water to flow gently down the inside of the appropriate size glass containers. Cap the sample container tightly and place pre-labeled sample container in a cooler with ice.

<u>Pesticides/PCBs Sampling</u> - Samples will be collected by allowing the water to flow gently down the inside of the appropriate size glass containers. Cap the sample container tightly and place pre-labeled sample container in a cooler with ice.

<u>Metals Sampling</u> - Samples will be collected by allowing the water to flow gently down the inside of the appropriate glass or plastic containers and preserving with nitric acid (HNO_3) to a pH of < 2. Cap the sample container tightly and place pre-labeled sample container in a cooler with ice.

<u>Cyanide (Total and Amenable) Sampling</u> - Samples will be collected by allowing the water to flow gently down the inside of the appropriate glass or plastic containers and preserved with sodium hydroxide (NaOH) to a pH of > 12. Cap the sample container tightly and place pre-labeled sample container in a cooler with ice.

If determination of dissolved (soluble) metal concentrations is a sampling objective, then filtered water samples will be collected using the same low-flow method. The use of an in-line filter is required, and the filter size [0.45 micrometers (μm) is commonly used] should be based on the sampling objective. Pre-rinse the filter with approximately 25 to 50 ml of groundwater prior to sample collection. Preserve the filtered water sample immediately. [Note: Filtered water samples are not an acceptable substitute for unfiltered samples when the monitoring objective is to obtain chemical concentrations of total mobile contaminants in groundwater for human health risk calculations].

After collection of the samples, the pump tubing may either be dedicated to the well for resampling (by hanging the tubing or leaving the previously dedicated tubing inside the well), decontaminated, or properly discarded. Intermediate tubing segments used to connect top-hole accessories will be decontaminated or discarded.

Secure the well by installing the riser cap, and placing a padlock on the protective casing cap.

10.0 Handling and Preservation

The type of analysis for which a sample is being collected determines the type of bottle, preservative, holding time, and filtering requirements. Ideally, sample containers will be labeled appropriately prior to sample collection; however, if this is not possible, sample containers will be labeled immediately after sample collection.

Trip blanks are used to assess the degree of contamination introduced into samples during sample handling, shipment, and analysis. Contamination may be introduced from the sample bottle, the preservatives used, cross-contamination (in the case of VOCs), or from shipping and handling, both in the field and in the laboratory. Samples are shipped to analytical laboratories expeditiously to ensure that holding times are not exceeded. Chemical preservatives used during groundwater sampling activities include HCl, HNO_3, and NaOH.

Preservative will be added, as required by analytical methods, to samples after they are collected, if the sample containers are not pre-preserved. VOC samples (collected in 40-ml vials) are pre-preserved with 2 drops of HCl. HNO_3 will be added (following sample collection) to samples collected for metals (total or dissolved) analyses until a pH of less than 2 is obtained. NaOH will be added (following sample collection) to samples collected for cyanide analyses until a pH of greater than 12 is obtained.

Following preservation, sample information will be recorded on the appropriate chain of custody form, and samples will be placed in a cooler to be maintained at 4°C. Samples must be analyzed before the holding time expires, and preferably shipped within 24 hours of sample collection. It is imperative that these samples be shipped or delivered daily to the analytical laboratory in order to maximize the time available for the laboratory to perform the analysis. The bottles should be shipped with adequate packing and cooling material to ensure that they arrive intact and at 4° C.

11.0 Sample Preparation and Analysis

This section is not applicable to this SOP.

12.0 Troubleshooting

All field screening instrumentation (PID and/or FID, and YSI meter) and pumps must be calibrated and operated in accordance with operating instructions as supplied by the manufacturer, unless otherwise specified in the site-specific SOPs. Equipment checkout and calibration activities must occur prior to and following sampling activities, and they must be documented.

13.0 Data Acquisition, Calculations, and Data Reduction

Field observations made during the sampling event will be recorded in a site logbook and/or field data sheets, including description of sampling locations and any deviations from the site-specific SOPs. Chain-of-custody will be maintained until samples are relinquished to a courier or to the laboratories assigned to perform the analyses. Photographs may be taken to document site conditions. The location and direction from which photographs are taken will be noted in the field logbook, in accordance with the scope of work. Reports, site file memoranda, figures, tables, boring logs, etc. will be saved in site-specific Technical Direction Document (TDD) directories.

14.0 Quality Assurance and Quality Control Section

All observations and field parameters must be documented on field data sheets, team member's logbooks, or in site-specific logbooks. All instrumentation must be operated in accordance with operating instructions as specified by the manufacturer, unless otherwise specified in the site-specific SOPs or SAP. Instruments shall be calibrated at the beginning of each day. If a measurement falls outside the calibration range, the instrument should be recalibrated so that all measurements fall within the calibration range. At the end of each day, instruments should be recalibrated to verify that instruments remained in calibration.

This section describes quality assurance/quality control (QA/QC) pertinent to low-flow groundwater samples, and the types and uses of the QA/QC samples that are collected in the field. Quality control samples are required to verify that the sample collection and handling process has not compromised the quality of the groundwater samples. All field quality control samples must be prepared identically to regular investigation samples with regard to sample volume, containers, and preservation. QA/QC samples provide information on the variability and usability of environmental sample results. They assist in identifying the origin of analytical discrepancies to help determine how the analytical results should be used. They are used mostly to validate analytical results.

A data quality review of the laboratory sample analyses will be conducted by U.S. EPA. As part of this validation process, a memorandum is prepared with tables qualifying the data.

Field replicates, matrix spike/matrix spike duplicate (MS/MSD), trip blanks, rinsate (equipment) blanks, and temperature blanks are discussed below. QA/QC results may suggest the need for modifying sample collection, preparation, handling, or analytical procedures if the resultant data do not meet quality assurance objectives.

14.1 Field Replicates

Field replicates are used to assess the degree of sample heterogeneity, and the reproducibility of the sample collection procedure and the laboratory analysis. Field replicates are typically collected with groundwater samples which are submitted for Site Assessment scoring activities. For this procedure, replicates will be collected for each analyte group in consecutive order (VOC original, VOC duplicate, SVOC original, SVOC duplicate, etc.).

If split samples are to be collected, the split for each analyte group will be collected in consecutive order (VOC original, VOC split, etc.). Split samples should be as identical as possible to the original sample.

14.2 Laboratory Matrix Spike and Matrix Spike Duplicate

MS and MSD samples are used to monitor laboratory performance. MS/MSD samples are spiked in the laboratory with a known concentration of a target analyte(s) to verify percent recoveries. It may be necessary to provide extra volume of a sample to the laboratory for spiking analyses. Extra volume for MS/MSD or MS/Duplicate (Dup) analyses is collected for every 20 samples of groundwater for each requested analytical parameter.

14.3 Trip Blanks

Trip blanks are typically collected for VOC analysis. Trip blanks are used to assess the degree of contamination introduced into samples during sample handling, shipment. Contamination may be introduced from the sample bottle, the preservatives used, cross-contamination (in the case of VOCs), or from shipping and handling, both in the field and in the laboratory. Trip blanks (organic-free water) will be prepared prior to the groundwater sampling event. Each bottle of the trip blank sample will be preserved with two drops of 1:1 HCl per 40 ml of sample to achieve a pH < 2. Trip blanks are handled, transported, and analyzed in the same manner as the other samples collected for that analysis that day. One set of trip blanks is collected/prepared for VOC analysis for each day in which VOC samples are shipped.

14.4 Rinsate (Equipment) Blanks

Dedicated or decontaminated sampling equipment may be used at each groundwater sample location to minimize cross-contamination. Groundwater sampling equipment must be decontaminated prior to the start of sampling activities as well as between sample locations, unless the sampling activity is dedicated to one sample location. Rinsate blanks are used to assess contamination (typically, cross-contamination) brought about by improper decontamination procedures between sampling stations. Rinsate blanks are not required for dedicated, disposable sampling implements. If a non-dedicated submersible pump is used, then a rinsate blank must be collected from the pump and its associated tubing. If only the tubing is dedicated to the well, the rinsate blank will only include the pump (if using a submersible pump) in subsequent sampling rounds. If tubing is dedicated to the well and a peristaltic pump is used, an equipment blank is not required.

Rinsate blanks are obtained by running (or pumping) analyte-free water through decontaminated sampling equipment to test for residual contamination. The water is collected into the appropriate sample containers, which are handled (e.g., preserved), shipped, and analyzed identical to the samples collected that day. Where non-dedicated sampling equipment is used, rinsate blanks must be collected at the rate of one per day per 20 stations for each parameter for which groundwater samples are collected.

14.5 Temperature Blanks

Temperature blanks provide information on the preservation (temperature) of the samples during shipment to the laboratories. Temperature blanks are obtained by pouring tap water into an unpreserved sample bottle and placing one temperature blank per cooler of samples.

15.0 Reference Section

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STANDARD OPERATING PROCEDURE FOR LOW-FLOW GROUNDWATER SAMPLING
(after Puls and Barcelona, 1996)

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June 2001

Sample Procedures to be Used for Low-Stress Sampling:

A low-flow purge and sample method will be used for this sampling event. The low-flow purge and sample method creates less disturbance and agitation in the well, and therefore excess turbidity is not generated during the purging and sampling process. The result is more rapid stabilization of turbidity and other field parameters, hence, a sample which is more representative of conditions in the formation. The field parameters which will be measured in the field are turbidity, dissolved oxygen, pH, redox, temperature, and conductivity. At a minimum, dissolved oxygen will be measured using a flowthrough-cell. Monitoring wells with the least contamination will be sampled first. The following procedure will be used for sample collection:

1. Check and record the condition of the well for any damage or evidence of tampering.

2. Unlock well head and then remove PVC cap from inner casing.

3. Measure and record the depth to water with an electronic water level device and record the measurement in the field logbook. Do not measure the depth to the bottom of the well at this time (to avoid disturbing any sediment that may have accumulated). Calculate volume of the water column as: depth of water multiplied by the cross-sectional area of the well.

4. Lay out the polyethylene sheeting and place the monitoring, purging and sampling equipment on the sheeting. To avoid cross-contamination, do not let any downhole equipment touch the ground.

5. Re-check and record the depth to water after approximately 5 minutes. If the measurement has changed more than 0.02 ft, check and record the measurement again, then begin well purging.

6. Attach and secure new polyethylene tubing to the low-flow pump. Slowly lower the tubing into the well; place the tubing at the midpoint of the screen. If a dedicated pump and tubing are installed, attach a short piece of intermediate tubing between the dedicated tubing and flow-through cell.

7. Start pumping the well at a flowrate of approximately 300 to 500 mL/min, maintain a steady flow rate.

8. The water level in the well should be monitored during pumping, and ideally the pump rate should equal the well recharge rate with little or no water level drawdown in the well. Record the pumping rate and depth(s) to water in the logbook. If the recharge rate of the well is very low and the well is purged dry, then the sampler must wait until the well recharges to a sufficient level and then collect the appropriate volume of sample.

9. During the purging, the field parameters must be monitored and recorded for every sample tube volume (length of tubing measured from midpoint in the screen to the point of discharge). Once

three successive readings of the field parameters agree within the specified ranges, then the purge water is considered stabilized and sampling may begin.

10. Sampling rate should be the same rate as the purge rate in order to minimize sample disturbance.

11. The dissolved metals samples must be filtered. An in-line 0.45 μm filter will be used at the well head. It may be necessary to increase the pumping rate to get the water to flow through the filter. Therefore, metals should be collected last in the sequence.

12. When the sampling has ended, but prior to turning the pump off, one last reading and recording of the field parameters must be made.

13. After sampling is completed, measure the total depth of the well.

14. Close and lock the well.

15. Between sampling locations all non-dedicated sampling equipment must be disposed of or decontaminated. Tubing is to be disposed.

STANDARD OPERATING PROCEDURE
FOR
GROUND WATER SAMPLING
With the use of a HydroPunchR Direct Push Sampler

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TABLE OF CONTENTS

1.0 Summary

The HydroPunchR is a sampling tool constructed of stainless steel and teflon used for collecting groundwater samples. This document provides guidance for the use of this tool in ground water investigations.

2.0 Purpose and Scope

This document summarizes the minimum requirements for the use of the HydroPunchR (HP-I and HP-II) for the collection of ground water data for site investigations.

3.0 Method Overview

A. Tool

1. The HydroPunchR I (HP-I) sampling tool collects the sample in only one mode, within the sample chamber (Figure I). This tool collects ground water through the effect of in-situ hydrostatic head, therefore, the top of the sample chamber must be below the ground water table for sample acquisition. A sample cannot be collected across the ground water table with the HP-I. The HP-I is designed to be used by cone penetration or drill rig.

2. The HydroPunchR II (HP-II) sampling tool can be operated in two modes, hydrocarbon and water sampling (Figure II). The water sampling mode is similar in operation to the HP-I. In the hydrocarbon mode a PVC screen is exposed so samples can be collected across the ground water table of an unconfined aquifer to determine the presence of floating product. The HP-II was specifically designed to be used by drilling contractors. Its larger diameter limits the effective depth when pushed from the surface with cone penetration rigs.

B. Applications

1. Collection of ground water samples for the determination of the presence/absence and extent of ground water contamination.

2. Field screening tool to aid in the placement of monitor wells.

3. Temporary placement for the collection of ground water samples and estimating ground water flow directions (less than 48 hours).

C. Capabilities

1. Obtain ground water samples from unconfined aquifers.

2. Obtain ground water samples from confined aquifers provided the upper aquifer is cased off and the casing is driven a minimum of two feet into the confining layer.

3. Obtain samples across the water table to determine the presence of floating product (HP-II).

4. Capable of collecting samples to determine the vertical profiling of contaminants in an aquifer.

5. Ability to collect ground water samples from small discrete water bearing zones. (HP-I & HP-II).

6. Capable of being used with a cone penetration rig or a conventional drill rig.

7. A comparison of the advantages and limitations for both the HP-1 and HP-II are listed in Table I.

4.0 Sampling Method Requirements

A. Installation

1. The HydroPunchR is capable of use in unconsolidated formations only. When being installed, the drilling must stop above the target sample depth thereby not disturbing the zone to be sampled. It is therefore imperative to have some idea of the depth at which the sample will be collected. If little is known of the site geology, then an initial boring should be made to determine 1) depth of water bearing zones 2) permeability of sample zone 3) density of soil 4) identify the subsurface stratigraphy 5) other pertinent data for the investigation.

2. When used with a conventional drill rig the hole must be advanced (with hollow stem augers, mud rotary etc.) to the depth which is above the zone of interest, eliminating any interference from the drilling. The HydroPunchR may then be driven to the desired sampling interval for sample collection.

3. DO NOT set the HydroPunchR down on the bottom of the borehole and pick it up. This will open the tool and compromise the sample integrity. Damage to the tool may be incurred if it is driven after being opened. Also, caution must be taken not to back hammer when driving the HydroPunchR for the above stated reason.

4. Always accurately measure the distance the tool is pushed or driven and the distance pulled back.

5. Never pull the HydroPunchR back farther than it is pushed or driven into the undisturbed soil. This may result in cross contamination of the sample from other zones in the borehole, or loss of the casing (in the hydrocarbon mode) resulting in the inability for sample collection.

6. Installation of the tool is required to comply with all permit, license, sealing and grouting requirements as per Appendices I and II. Any tool left in the ground longer than 48 hours is considered a monitor well and therefore must comply the permit, installation and license requirements for monitor wells.

B. Sampling Procedures

1. Hydrocarbon Mode (HP-II)

a. The hydrocarbon mode is used to collect ground water samples when:
   - A sample must be obtained from the water table interface of an unconfined aquifer.
   - A large volume of sample is required.
   - The presence of floating product is suspected.

b. A sacrificial 0.010-inch PVC screen (approx. 5') is attached to a disposabledrive cone. The screen and drive cone are then inserted into the body of the HP-II until the O-Ring on the cone is sealed in drive shoe. Place the sleeve over the juncture of the drive cone and body of the unit.

c. Once driven to the desired depth, the body of the unit is pulled back exposing the screen. Friction with the seal will hold the cone in position while the screen is exposed. Do not pull back a distance greater than the length of the screen.

d. The EW, BW, or NW casing used to drive the tool allows for the placement of a small diameter bailer (3/4" or 1") to be lowered down through the casing and body of the HP-II and into the screen for sample collection.

e. The Hydropunch does not have to be purged or developed prior to sampling.

2. Water Sampling Mode (HP-1 and HP-II)

a. The HP-II in the ground water sampling mode or HP-I can be used when samples are required at a minimum of five (5) feet below the top of the water table and when a small sample volume (500 ml-1,200 ml dependent upon tool) is adequate.

b. Place the lower check valve with attached filter screen into the bottom of the tool body and place the upper check valve in the top of the tool. Insert the disposable drive cone into the drive shoe ensuring a seal is made by the O-Ring. Place sleeve over the juncture of the drive cone and drive shoe.

c. Push or drive (with 140 lb hammer, 30 inch travel) the unit to the desired depth and pull back approximately two (2) feet. Soil friction will hold the drive cone in place.

d. Ground water flows into the intake screen past the lower check valve, into the sample chamber and finally out the top check valve.

e. When full the tool is pulled to the surface, increasing the hydrostatic head within the tool closing the two check valves.

f. At the surface the HP-II is inverted and the sample is decanted through a discharge valve and tubing into the sample containers.

C. Quality Assurance/Quality Control

1. Decontamination
The HydroPunchR, drill rods and drive casing must be decontaminated between samples using the following procedure:

a) Disassemble the HydroPunchR unit and remove O-Rings. The PVC screen is disposable and must be discarded.

b) Scrub with a laboratory grade glassware detergent.

c) Rinse with potable water and/or steam clean.

d) Rinse entire unit with distilled and deionized ASTM Type II water.

e) Replace O-Rings.

f) Reassemble unit.

g) The PVC screen is supplied by the manufacturer already cleaned. If the packaging is compromised then it should be cleaned in the same manner as the HydroPunch and casing.

2. Field Blanks

Field blanks must be obtained in the same manner as samples (i.e., if hydrocarbon mode is used blank water must pass through bailer, screen and HydroPunchR body).

3. Sample Equipment

All sampling equipment must be decontaminated in accordance with the WESTON Field Sampling Procedures Manual and dedicated to each sample point.

4. Rod Sealing

When using the HydroPunchR in the hydrocarbon or ground water mode for obtaining samples deep in the unconfined aquifer or in a confined aquifer, or using the unit with hollow stem augers on mud rotary drilling, the drill rod/casing joints must be sealed. This will prevent fluid from entering the rods and potentially contaminating the sample. The rods should be sealed with TeflonR tape on the threads. Once put together the joints must be sealed with gas pipe tape. Another option is the use of drill rod with O-Rings at the threads for sealing.

5. Formation Types

The HydroPunchR can be installed in unconsolidated materials. Varying amounts of pebbles,cobbles and boulders may impede advancement or damage the tool.

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4. Cordry, Kent; HydroPunch II - The Second Generation. A New In Situ Ground Water Sampling Tool. In Procedures of the Fifth National Outdoor Action Conference on Aquifer Restoration Ground Water Monitoring, and Geophysical Methods. pp 715-723 May 13-16, 1991, Las Vegas, Nevada.

5. Strutynsky, A.I.; Sainey, T.J.; Use of Piezometeric Cone Penetration Testing and Penetration Ground Water Sampling for Volatile Organic Contaminant Plume Detection. In Procedures of the Petroleum Hydrocarbons and Organic Chemicals in Ground Water: Prevention, Detection and Restoration. p70-84. October 1990, Houston, TX.

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STANDARD OPERATING PROCEDURE FOR MONITORING WELL INSTALLATION AND WELL DEVELOPMENT

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2 May 2001

APPROVALS

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Approved by: ______________________ Date: 06/01/2001
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1.0 Scope and Applicability

The purpose of this Standard Operating Procedure (SOP) is to provide an overview of the methods used by Roy F. Weston, Inc. (WESTON®) personnel for monitoring well installation and well development. Properly installed monitoring wells provide sample location points for the collection of groundwater samples to determine groundwater quality, and subsurface soil samples to identify potential sources of contamination and subsurface soil characteristics (texture, composition, etc.). In addition, monitoring wells may be used to determine water table elevations and groundwater flow directions, and to determine hydrogeologic properties of the aquifer in which the contaminants may exist. Purposes for the installation of monitoring wells and rationale will be detailed in site-specific Sampling and Quality Assurance Plans (SQAPs) and may include determining whether concentrations of hazardous substances in groundwater exceed established action levels, confirming or identifying hazardous substances that may have impacted the environment, determining if contaminants are migrating off site, or if the concentrations of hazardous substances may present a risk to public health, welfare, or the environment.

1.1 Monitoring Well Installation

WESTON procures the services of a qualified driller via a Request For Proposal (RFP) under the Federal Acquisition Regulations (FAR) to perform drilling services. The RFP details the Scope of Work for the site, and is divided into technical, administrative, health and safety, and general requirements. Since geologic information is recorded during this activity, a Geologist or qualified member will be assigned to the project.

During the advancement of borings in which monitoring wells will be installed, WESTON personnel will collect subsurface soil samples from split spoons; and following installation and development of monitoring wells, WESTON personnel will collect groundwater samples. WESTON has prepared separate SOPs, entitled *Standard Operating Procedure For Surface and Subsurface Soil Sampling, Standard Operating Procedure For Low-Flow Groundwater Sampling*, and *Standard Operating Procedure For Groundwater and Drinking Water Sampling*. These SOPs should be reviewed prior to collecting subsurface soil and groundwater samples.

The most commonly used drilling methods are hollow-stem augers, cable tool drills, and rotary drills. Rotary drilling can be divided into a mud rotary or air rotary methods.

1.2 Well Development

The purpose of monitoring well development is to ensure removal of fines from the vicinity of the well screen. This allows free flow of water from the formation into the well and also reduces the turbidity of the water during sampling events. The most common well development methods include surging, jetting, and overpumping.

Surging involves raising and lowering a surge block or surge plunger inside the well. The resulting motion forces water into the formation and loosens sediment to be pulled from the formation into the well. Occasionally, sediment must be removed from the well with a sand bailer to prevent sand locking of the surge block. This method may cause the sand pack around the screen to be displaced to a degree that damages its value as a filtering medium. For example, channels or voids may form near the screen if the filter pack sloughs away during surging.

Jetting involves lowering a small diameter pipe into the well to a few feet above the well screen, and injecting water or air through the pipe under pressure so that sediments at the bottom are geysered out the top of the well. It is important not to jet air or water directly across the screen. This may cause fines in the well to be driven into the entrance of the screen openings thereby causing blockages.

Overpumping involves pumping at a rate rapid enough to draw the water level in the well as low as possible, and allowing it to recharge. This process is repeated until sediment free water is produced. Overpumping is not as vigorous as surging and jetting, and is probably the most desirable for monitoring well development.

2.0 Summary of Method

2.1 Monitoring Well Installation

The type of drilling method used depends on site conditions (accessibility, terrain, on-site structures, etc.), hydrogeologic conditions, and project objectives. No one drilling method is universally used and many times more than one drilling method is used on the same project. The RFP included in this attachment provides for three types of drilling methods. The most common drilling methods employed include hollow-stem augering, drive and wash, air rotary, and driven wells (well points). Each of these is summarized below.

- Hollow-Stem Augering - Hollow-stem augering is fast and relatively less expensive than rotary drilling methods. It is possible to drill several hundred feet of borehole per day in unconsolidated formations.

- Drive and Wash - The drive and wash drilling method involves the driving of steel casing, generally in 5-foot intervals using a manually controlled 300-pound or greater hammer, and advancing the borehole by the rapid rotation of a drill bit, which cuts and breaks the material in the casing. Cuttings are removed by pumping drilling fluid (water) down through the drill rods and bit, and up the annulus between the borehole and the drill rods.

- Air Rotary Method - The air rotary method uses compressed air which is pumped down the drill rods and returns with the drill cuttings up through the annulus. The air rotary method is generally limited to consolidated and semi-consolidated formations.

A casing is sometimes used to prevent cavings in semi-consolidated formations. The air must be filtered to prevent introduction of contamination into the borehole.

- Driven Wells - Driven wells consist of a wellpoint (screen) that is attached to the bottom of a casing (riser). Typically 1-inch diameter stainless steel drive points are installed using a hand-operated slide hammer or sledge hammer. The stainless steel drive points consist of a short length of longitudinally slotted (typically 0.5 to 1 foot) or screened (typically 2 to 5 feet) section threaded to a steel riser pipe.

2.2 Monitoring Well Development

Development of a well should occur as soon as practical after installation, but not sooner than 48 hours after grouting is completed, if a rigorous well development is being used. If a less rigorous method, such as bailing is used for development, it may be initiated shortly after installation. The main concern is that the method being used for development does not interfere with allowing the grout to set.

3.0 Acronym List

cc	-	Cubic centimeters
CLP	-	Contract Laboratory Program
DAS	-	Delivery of Analytical Services
DOT	-	Department of Transportation
EPA	-	U.S. Environmental Protection Agency
FAR	-	Federal Acquisition Regulations
FID	-	Flame Ionization Detector
GPS	-	Global Positioning System
HASP	-	Health and Safety Plan
IDW	-	Investigation-derived wastes
pest/PCB	-	Pesticide/Polychlorinated Biphenyl
O.D.	-	Outside Diameter
OSHA	-	Occupational Safety and Health Administration
PID	-	Photoionization Detector
PPE	-	Personal Protective Equipment
PVC	-	Polyvinyl Chloride
RFP	-	Request for Proposal
RQD	-	Rock Quality Determination
SOP	-	Standard Operating Procedure
SQAP	-	Sampling and Quality Assurance Plan
START	-	Superfund Technical Assessment and Response Team
TDD	-	Technical Direction Document

VOC - Volatile Organic Compound
WESTON - Roy F. Weston, Inc.

4.0 Health and Safety Warnings

WESTON personnel performing work on hazardous waste sites will follow Occupational Safety and Health Administration (OSHA), U.S. Environmental Protection Agency (EPA), and WESTON specific health and safety procedures and protocols. WESTON personnel conducting on-site soil sampling activities will also be performing tasks in accordance with EPA-approved SQAPs.

In order to ensure the safety of personnel during drilling activities, the buddy system, periodic air monitoring, and caution will be used throughout field activities. To minimize risks due to chemical exposure, dermal and respiratory protection may be required if air monitoring equipment indicates that the environment is unsafe. Field activities will follow the site Health and Safety Plan (HASP), which further addresses the safety considerations of the property. Hazards identified in or around the site may include physical hazards (slips, trips, and falls). Additional potential hazards exist in association with drilling activities; therefore, WESTON and its drilling subcontractors will utilize the WESTON Drilling Safety Guide and will follow industry standards and protocols for all activities involving drill rigs or similar apparatus for the purpose of soil boring and monitoring well installation.

For any field assignments involving the collection of subsurface samples, excavation, or any other type of intrusive activities, it is a legal requirement to call the appropriate utility clearance center before beginning any intrusive activities on site.

Decontamination wastes generated during drilling activities will be collected and secured on site. Separate containers will be used for the drill cuttings and purge water. Proper personal protection will be worn during decontamination procedures and will include gloves, eye protection, and splash-resistant protective clothing. Drill cuttings and purge water will be contained in 55-gallon drums provided by the drilling subcontractor; however, the drilling subcontractor will not be responsible for off-site disposal. Off-site disposal of decontamination wastes and contaminated personal protective equipment (PPE) will be conducted by WESTON for disposal of investigation-derived wastes (IDW). Non-contaminated wastes will be tightly sealed, double-bagged and disposed appropriately.

5.0 Interferences

5.1 Monitoring Well Installation

There are many advantages and disadvantages of the various drilling techniques. For example, the hollow-stem augering method is fast and relatively less expensive than rotary drilling methods; and the saturated zone is easily determined. It is possible to drill over 100 feet of borehole per day in unconsolidated formations. However, many of the areas in Region X contain glacial till and coarse gravel and refusal occurs frequently outside of alluvial valleys. Also, the hollow-stem augering method is not very effective in controlling heaving sands.

In the drive and wash method, steel casing is driven into the borehole by a 300-pound weight dropped through a 30-inch interval. After driving the casing 5 feet, a drill bit is attached to the end of the drill rods and the 5-foot interval is drilled. The rapid rotation of the drill bit cuts and breaks the material at the bottom of the hole into smaller pieces and the cuttings are removed by pumping drilling fluid (water) down through the drill rods and bit, and up the annulus between the borehole and the drill rods. The drilling fluid also serves to cool the drill bit and prevent the borehole from collapsing in unconsolidated formations. The drive and wash method is very effective for controlling heaving sands, but is more expensive than the hollow-stem augering method. It introduces water into the borehole making it difficult to identify the saturated zone, and is slower than the hollow-stem augering method for drilling in unconsolidated formations.

The air rotary method is used to drill into consolidated formations and bedrock. The air rotary method is similar to the drive and wash method except that compressed air is pumped down the drill rods and returns with the drill cuttings up through the annulus. Casing is sometimes used to prevent cavings in semi-consolidated formations. The air must be filtered to prevent introduction of contamination into the borehole. The air rotary method is effective drilling through glacial till and into bedrock, but is more expensive than the hollow-stem augering method. Air discharge from a compressor commonly contains hydrocarbon-related contaminants. For this reason it is necessary to install filters on the discharge of the compressor.

Well Points installed by WESTON generally consist of 1-inch diameter slotted stainless steel drive points. Well points are installed using either a hand-operated slide hammer or sledge hammer, or a pneumatic hammer. Well points are installed in remote areas or in areas that are not accessible to drill rigs. The installation of well points is inexpensive and can be done very quickly; however, they are installed at shallow depths (less than 10 feet). Well points can be installed at depths greater than 10 feet depending on overburden conditions (type of material comprising the overburden).

Each of these drilling methods is discussed Section 9.3, Drilling and Monitoring Well Installation.

5.2 Well Development

Interferences or problems that may be encountered during well development include the possibility of disturbing the filter pack with aggressive surging and jetting well development methods, and altering the hydrochemistry of the aquifer by introducing external water or air by jetting.

6.0 Personnel Qualifications

Drilling oversight, monitoring well installation, and well development is performed by experienced WESTON geologists/hydrogeologists or other qualified personnel having extensive experience in drilling operations. Training of WESTON personnel will be provided to ensure that technical, operational, and quality requirements are understood. Personnel are trained in-house to provide monitoring well installation and well development. Training includes reviewing this SOP and other applicable SOPs and/or guidance documents, health and safety training, "hands-on" experience assisting more experienced Geologists/Hydrogeologists or other qualified personnel conducting drilling oversight, monitoring well installation, and well development; and with instrument calibrations.

7.0 Apparatus and Materials

The drilling contractor will provide all operational equipment for the drilling program which is outlined. WESTON should bring equipment/materials for performing drilling oversight and monitoring well installation. Equipment should include, but is not limited to the following:

- Site-specific SQAPs.
- Standard Operating Procedure for Monitoring Well Installation and Well Development.
- Safety equipment specified in the site Health and Safety Plan.
- Site-specific Request for Proposal for Monitoring Well Installation and Well Development.
- Field map of site.
- Log book.
- Field data sheets (e.g. boring logs, grain size charts, Munsell color chart).
- Graph paper.
- Ruler.
- Water level indicator.
- Depth sounder.
- Camera and film.

- Spatula, scoops, or trowel.
- Stainless steel or plastic homogenization bucket or bowl.
- Sampling jars.
- Decontamination fluids (supplies)/equipment (pump sprayers, brushes, etc.).
- Plastic sheeting (Visqueen).
- Plastic tubs.
- Sealable plastic bags.
- Labels.
- Chain-of-custody forms and seals.
- Coolers and ice.
- Vermiculite.
- Strapping tape.

In general, the well should be developed shortly after it is drilled. Most drilling rigs have air compressors or pumps that may be used for the development process.

8.0 Method Calibration

This section is not applicable to this SOP.

9.0 Monitoring Well Installation

9.1 Off-site Preparation

WESTON procures the services of a qualified driller via a RFP to perform drilling services. The RFP details the Scope of Work for the site and is divided into technical, administrative, health and safety, and general requirements. During the procurement process, the drillers may be requested to attend a site walk-through to discuss the scope of work, access issues, and other issues related to the project. Following the submission of bids by the drillers and evaluation of the bids by WESTON, one driller is awarded the subcontract.

Following EPA approval of the site-specific SQAPs, and prior to conducting drilling and monitoring well installation activities, a pre-sampling meeting will be held by WESTON to discuss the proposed drilling strategy and site health and safety issues. During the pre-sampling meeting, the Site Leader will discuss the site history, contaminants of concern, drilling program (drilling methods, rationale for well placement, well construction details, etc.), subsurface sampling methodology, individual responsibilities, sample shipment or delivery, health and safety issues, and lines of communication anticipated during the drilling activities.

Prior to mobilizing to the site to conduct drilling activities, the Site Leader will fill out an equipment/supply list and transmit the list to the WESTON Equipment Stores technician one week prior to the sampling event. Necessary sampling equipment, sample containers, PPE, and vehicles are therefore reserved. Contract Laboratory Program (CLP) and/or Delivery of Analytical Services (DAS) laboratories are procured or secured one week prior to the sampling event also.

9.2 On-site Preparation

Prior to conducting any on-site activities, WESTON personnel will review and sign the site-specific HASP. The field team will establish a command post upwind of suspected source areas, if possible. WESTON will perform calibration checks of air monitoring instruments and document background ambient air monitoring levels.

Prior to any field work, the driller and driller's helper will meet with the WESTON Geologist or other qualified personnel to discuss the drilling program, conduct a site walk-through, and discuss site safety and access issues. The number of soil borings to be advanced and number of monitoring wells to be installed are described in the approved site-specific SQAP and RFP.

Drilling activities will be organized to minimize contamination of equipment and the drilling subcontractor is responsible for decontaminating all equipment prior to use at the site. The drilling subcontractor is responsible for decontaminating the split spoons, after each boring and upon leaving an exclusion (i.e., potentially contaminated) zone. A vehicle and equipment decontamination area will be established by the drilling subcontractor. The drilling subcontractor will be required to follow WESTON's instructions for the proper decontamination of vehicles and equipment. Decontamination water will be collected in drums provided by the drilling subcontractor at the vehicle and equipment decontamination area for subsequent disposal.

Decontamination of the drill rigs and accessories between borings will consist of removing loose soil from the tracks, augers, casing, and drill rods and rinsing by using a steam and/or pressure washer equipped with an intermittent cleaning material siphon. Non-phosphate detergent solution will be used as a primary cleaning agent, and clean rinse water will follow. All extracted materials will be decontaminated by the drilling subcontractor prior to disposal with the steam and/or pressure washer.

Additionally, split spoon sampling devices will be rinsed between samples using non-phosphate detergent followed by a clean water rinse water. All decontamination rinsate will be containerized in 55-gallon steel drums. The drilling subcontractor shall be responsible for providing all necessary decontamination materials, including a water supply (minimum of 500 gallons). In addition, WESTON will provide decontamination fluids and applicators to be used on the split spoons between sampling intervals at the same boring.

All extracted materials will be decontaminated by the driller prior to disposal with the steam cleaner. Equipment decontamination fluids and PPE generated during sampling activities will be containerized and disposed appropriately based on the results of laboratory analyses of samples collected.

9.3 Drilling and Monitoring Well Installation

The most common drilling methods employed include the hollow-stem augering, drive and wash, air rotary, and driven wells points. Each of these is drilling methods and subsequent monitoring well installation is summarized below.

9.3.1 Hollow Stem Auger Method

Hollow stem auger drilling is accomplished by using a series of interconnected auger flights with a cutting head at the lowermost auger. A center plug is used to prevent the intrusion of material into the auger while drilling. As the augers are rotated and pressed downward, the cuttings are rotated up the continuous flighting. The center of the auger is open, therefore, as the augers are rotated and pressed into the ground, the augers act as casing and stabilize the borehole. Small diameter drill rods and samplers can then be passed through the hollow center of the augers for sampling. The casing [typically polyvinyl chloride (PVC) riser and well intake (PVC screen) can also be installed without borehole collapse.

WESTON generally collects split spoon samples beginning at the 0-foot to 2-foot interval. Generally, a 2-inch outside diameter, 2-foot long split spoon (with a spoon trap) is driven by a 140-pound weight dropped through a 30-inch interval. A 3-inch outside diameter split spoon is sometimes used where a large volume of soil is required for several laboratory analyses. Diameters of the split spoons should be determined prior to sampling.

The number of blows required to drive the split-spoon sampler provides an indication of the compaction/density of the soils being sampled. The number of blows required to advanced the split spoon each 6 inches for the 2-foot interval is recorded in the site logbook or on field data sheets by WESTON. Upon reaching the desired sampling depth, the split spoon is slowly and carefully extracted from the boring. Split spoon samples are collected at intervals of 5 feet, beginning at the 0-foot to 2-foot interval and thereafter (i.e. 5 to 7 feet, 10 to 12 feet, 15 to 17 feet, etc.).

Once the split spoon is removed from the drill rods, the split spoon will be placed on plastic sheeting in a horizontal position and opened by unscrewing the bit and head and splitting the barrel. A photoionization detector (PID) or flame ionization detector (FID) will be used to screen the sample as soon as the split spoon is opened. WESTON will measure the length of the recovered core, describe the soil in the split spoon, collect soil for headspace screening, and record field measurements and comments on the boring log form or field log book.

The driller will then advance the borehole by rotating and pressing the augers downward to the next desired sampling depth (typically 5 feet). The drill rods are then withdrawn and a clean (decontaminated) split spoon is attached and lowered to the bottom of the borehole until it rests on top of the undisturbed soil. In order to obtain representative soil samples, the bottom of the borehole must be clean and the soil to be sampled must be undisturbed. The split spoon is driven to the desired depth (e.g., 5 - 7 feet), and the number of blows required to advanced the split spoon each 6 inches for the 2-foot interval is recorded in the site logbook or on field data sheets by WESTON. The split spoon is slowly and carefully extracted from the boring. WESTON will measure the length of the recovered core, describe the soil in the split spoons, collect soil for headspace screening, and record field measurements and comments on the boring log form or field log book.

Another 5-foot auger flight is attached and the augers are then rotated and pressed into the ground to the next desired sampling depth (10 feet) and the procedures for advancing split spoons, describing soils, headspace screening, etc. continues until the desired total depth of the boring is reached. A monitoring well will be constructed in the borehole or the borehole will be properly plugged according to state regulations or guidance if a monitoring well is not installed in the boring.

9.3.1.1 Well Construction

Monitoring wells are constructed with casings and materials that are resistant to the subsurface environment. The most commonly used casing materials include PVC, Teflon, and stainless steel. The selection of well construction materials is based on the material's long-term interaction with the contaminated groundwater. Construction materials should not cause an analytical bias in the interpretation of the chemical analysis of the groundwater samples. Well casing material should also be judged from a structural standpoint. Materials should be rigid and nonporous. The following procedures should be followed when installing a monitoring well.

When the desired depth is reached, the augers will be flushed if necessary to remove any loose material. The length of the screens and their location in the boring are specified in the RFP, however, these may be modified in the field based on subsurface conditions. WESTON generally uses 10-foot screens in most of its projects.

The casing and screen will be centrally positioned in each borehole to ensure the even placement of the filter pack and seals, and will reduce the possibility for the occurrence of voids. The screen and riser pipe will be vertically plumb to ensure that accurate water level measurements are obtained and provide for easier installation of the filter pack and seal materials. The casing sections should be firmly joined with leak-tight joints. If needed, Teflon tape or O-rings can be used on joints to help prevent leakage; however, no substances, such as glues, that may potentially contaminate the well may be used. The driller will provide quality assurance documentation on the source and purity of the filter sand and bentonite prior to their use in the borehole

A minimum of 2 feet of filter pack above the well screen and 3 to 4 inches below the well screen will be used. The filter material (sand) will be poured down the annular space between the outside of the well screen and riser and inside of the augers. The sand shall be added slowly to avoid bridging. If bridging does occur, water will be added or the riser pipe will be moved in short, quick movements to free the sand pack. A small amount of sand (approximately 3 to 4 inches) shall be allowed to fill the space below the bottom of the well screen. The augers shall be slowly retracted approximately 0.5 to 1 foot so that the filter pack can fill the space between the well screen and the borehole wall. The depth to the top of the filter pack shall be tamped and measured with weighted tape to verify its location each time the augers are retracted. The amount of filter pack installed will be recorded by the driller.

For wells deeper than approximately 50 feet, or when recommended by the WESTON Geologist, the filter pack will be emplaced using a tremie pipe (normally consisting of a 1.25-inch PVC or steel pipe). A sand slurry composed of sand and potable water will be pumped through the tremie pipe into the annulus throughout the entire screened interval, and over the top of the screen. It is necessary to pump sufficient sand/gravel slurry to cover the screen after the sand/gravel pack has settled and become dense.

The depth of the top of the filter pack will be determined using the tremie pipe, thus verifying the thickness of the sand pack. The top of the filter pack should be approximately 2 feet above the top of the well screen. Under no circumstances should the sand pack extend into any aquifer other than the one to be monitored.

A divider seal, consisting of bentonite chips or granular bentonite, will be placed above the well screen and will be approximately 2 feet (and at least 1 foot) thick. The divider seal is placed between the sand pack and grout to prevent infiltration of cement into the filter pack and the well screen. The bentonite should have a minimum purity of 90% montmorillonite clay, and a minimum dry bulk density of 75 lb/ft^3 for

½-inch pellets, as provided by American Colloid, or equivalent. Bentonite pellets should be poured directly down the annulus. Care must be taken to avoid introducing pellets into the well bore. A cap placed over the top of the well casing before pouring the bentonite pellets from the bucket will prevent this. To ensure even application, the pellets should be poured from different points around the casing. To avoid bridging of pellets, they should not be introduced at a rate faster than they can settle. Potable water will be added to the bentonite after placement to hydrate and expand the bentonite prior to placement of a bentonite and/or cement grout mixture.

An annular seal, consisting of a bentonite and/or cement grout mixture, will be placed by tremie pipe, directly above the divider seal. The placement of grout using a tremie pipe must be performed with the tremie pipe held in place at the base of the interval to be grouted until the upper surface of the grout is measured to be at its desired elevation within the borehole annulus; upon which the point the tremie pipe will be retracted.

Only Type I or II cement without accelerator additives may be used. An approved source of potable water must be used for mixing grouting materials. The following mixes are acceptable:

- Neat cement, a maximum of 6 gallons of water per 94-pound bag of cement.
- Granular bentonite, 1.5 pounds of bentonite per 1 gallon of water.
- Cement-bentonite, 5 pounds per pure bentonite per 94-pound bag of cement with 7-8 gallons of water; 13-14 pounds weight, if dry mixed.
- Cement-bentonite, 6 to 8 pounds of pure bentonite per 94-pound bag of cement with 8-10 gallons of water, if water mixed.
- Non-expandable cement, mixed at 7.5 gallons of water to ½ teaspoon of aluminum hydroxide, 94 pounds of neat cement (Type I) and 4 pounds of bentonite.
- Non-expandable cement, mixed at 7 gallons of water to ½ teaspoon of aluminum hydroxide, 94 pounds of neat cement (Type I and Type II).

The top 2 to 5 feet of the borehole will be filled with concrete to create a surface seal at least 6 inches thick above the borehole, with a diameter of at least 6 inches greater than the protective casing. The concrete slab will be contoured to direct surface water runoff away from the wellhead. Surface seals around protective well casings will be designed so that they are sloped and watertight to prevent the entry of surface water runoff. The protective casing will be 1 to 2 inches smaller than the borehole diameter, and the inside diameter will be sufficiently large to permit easy removal of the riser cap for sampling and measurement activities. The bottom of the protective casing will be placed 1 to 3 feet below the ground surface. The annulus between the protective casing and the riser shall be filled with approximately 1 foot of sand. A drain hole may be placed in the protective casing at the surface of the seal to prevent water from accumulating and freezing between the protective casing and riser. A small vent hole (1/16 inch) may be drilled below the depth of the cap into the final section of the riser pipe to allow gas and air to escape. Guard posts in addition to the protective casing, may be installed in areas where vehicular traffic may pose a hazard to the monitoring well. Guard posts consist of 3-inch diameter steel posts or tee-bar driven steel posts. Groups of three are radially located 4 feet around each well 2 feet below and 4 feet above ground surface, with flagging in areas of high vegetation. Each post is cemented in-place. A flush mount of protective casing may also be used in areas of high traffic or where access to other areas would be limited by a well with stickup. The monitoring well will be locked. Well construction specifications may be modified in the field based on subsurface conditions. The driller will decontaminate downhole drilling equipment between sample locations.

Following installation of the monitoring well, WESTON will document monitoring well construction details and/or plugging processes in the field log book or boring log. At a minimum, the well construction information should show depth from surface grade, the bottom of the boring, the screened interval, casing material, casing diameter, gravel pack location, grout seal, and height of riser pipe above the ground. WESTON will also record the actual compositions of the grout and seal on the boring log form. A well construction diagram on the boring log form for each well installed will also be provided.

The monitoring wells will be developed no sooner than 24 hours after grouting is completed.. Well development is discussed in Section 9.4.

9.3.2 Drive and Wash Method

The drive and wash drilling method requires the use of steel casing to maintain an open borehole during drilling and sampling operations. A hardened steel drive shoe is placed on the lead casing and the lead casing is driven into place using a manually controlled 300-pound or greater hammer or an automatic hammer system. Blow counts may be recorded for discrete intervals (usually 6 inches) of casing penetration. Changes in strata may be detected by changes in the number of casing blows per foot, especially in shallow borings.

Once the casing length is driven to the desired depth (usually 5-foot intervals), the drive head is removed and drill rods with a tricone or rotary bit are placed inside the casing. The drill bit and rods should be measured prior to placement in the hole. After the bit is placed inside the casing, the rod sticking up should be measured to determine the depth of the bit. The drill rod should be marked at the point where the bit will be at the base of the casing. This marking procedure will prevent accidental drilling below the casing, and disturbing material to be sampled.

Drill (uncontaminated) water is forced through the drill rods to the bit to carry the cuttings up and out of the boring. It is imperative that the water ports in the cutting bit jet water out the side of the bit and not ahead of the bit as this causes disturbance of the soil below the casing. The water level should be maintained at the top of the casing during drilling operations, particularly when heaving sands are encountered. Recirculation of drilling water may continue if the boring is not contaminated.

Once the washing procedure is complete, the rods and bit are extracted while maintaining the water level at the top of the casing. A split spoon sample can be collected at this point.

WESTON will generally collect split spoon samples beginning at the 0-foot to 2-foot interval using a 2-inch outside diameter, 2-foot long split spoon (with a spoon trap) driven by a 140-pound weight dropped through a 30-inch interval. The number of blows required to advanced the split spoon each 6 inches for the 2-foot interval is recorded in the site logbook or on field data sheets by WESTON. Upon reaching the desired sampling depth, the split spoon is slowly and carefully extracted from the boring. Split spoon samples are collected at intervals of 5 feet, beginning at the 0foot to 2-foot interval and thereafter (i.e. 5 to 7 feet, 10 to 12 feet, 15 to 17 feet, etc.).

Once the split spoon is removed from the drill rods, the split spoon will be placed on plastic sheeting in a horizontal position and opened by unscrewing the bit and head and splitting the barrel. A PID or FID will be used to screen the sample as soon as the split spoon is opened. WESTON will measure the length of the recovered core, describe the soil in the split spoons, collect soil for headspace screening, and record field measurements and comments on the boring log form or field log book.

Following split spoon sample collection, the driving process continues at 5-foot intervals until the desired depth of the boring is reached. A monitoring well will be constructed in the borehole or the borehole will be properly plugged according to state regulations or guidance if a monitoring well is not installed in the boring.

As the casing is retracted, a monitoring well can be installed in the boring. Monitoring well construction details are similar to those described for hollow stem augers.

9.3.3 Air Rotary Method

In air rotary drilling, the drilling fluid (air) is compressed and pumped down through the drill rods and up the open hole. The rotary drill bit is attached to the lower end of the drill pipe, and the drill bit is advanced by rotating the drill stem at the surface by either a top head or rotary drive table. Downward pressure is attained either by pull-down devices or drill collars. Pull-down devices transfer rig weight to the bit while drill collars add weight directly to the drill stem. If drill collars are used, the rig holds back the excess weight to control the weight on the bit. Most rigs that are used to install monitoring wells use the pull-down devices because the wells are relatively shallow.

As the bit cuts into the formation, cuttings are immediately removed from the bottom of the borehole and transported to the surface by the air that is circulating down through the drill pipe and up the annular space. As air discharges cuttings at the surface, formation samples may be collected. When the penetrated formation is dry, samples are typically fine grained. Although they are representative of the formation penetrated, is it difficult to evaluate in terms of physical properties and characteristics of the formation. When small quantities of water are encountered during drilling, the size of the fragments that are discharged at the surface are much larger. These larger fragments provide better quality samples that are easy to interpret.

When drilling through relatively dry formations, thick water bearing zones can easily be identified as the drilling proceeds. However, thin water bearing zones are often not identified because the pressure of the air in the borehole exceeds the hydraulic pressure of the water-bearing zone, or the combination and quantity of dust and air discharged is sufficient to remove the small amount of moisture indicative of the thin water-bearing zone.

In hard consolidated rock, a down-the-hole-hammer can be substituted for a roller cone bit to achieve better penetration. With the down-the-hole-drill, the compressed air that is used to cool the bit is also used to actuate and operate the down-the-hole-hammer. When a down-the-hole-hammer is used, oil is required in the air stream to lubricate the hammer actuating device. Therefore, down-the-hole-hammers must be used with caution when constructing monitoring wells.

Monitoring wells drilled by air rotary methods in competent bedrock are typically installed as open-hole completions. Permanent steel casing with a welded cutting shoe is usually seated at least 10 feet into competent bedrock to provide a seal between the overburden and bedrock interface, and extends to approximately 3 feet above the ground surface. An overestimate of cement/bentonite grout will then be pressure-grouted into the bolehole using a tremie pipe. The cement/bentonite grout mixture will consist of 94 pounds of Portland cement (Type I) mixed with 3 to 5 pounds of powered Wyoming sodium bentonite and 7 gallons of tap water. Cement/bentonite grout will be drilled out of the borehole no sooner than 48 hours after grouting. A concrete slab will be poured around the casing and contoured to direct surface water runoff away from the wellhead. After the grout is drilled out and cleaned, a locking cap is welded onto the permanent casing and the well is locked.

If an open-hole bedrock well cannot be maintained, the well will be constructed using a 2-inch Schedule 40-PVC well screen (0.010-inch slots) with 2-inch PVC riser continuing up to the ground surface. Monitoring well construction details are similar to those described for hollow stem augers.

9.3.3.1 Rock Coring

At times, it may be necessary to collect bedrock cores. If so, then details of collecting cores will be provided in the site-specific SQAP. In situations where drilling through the overburden is required, the borehole will be advanced to the top of the bedrock surface using the hollow stem auger drilling method. Temporary steel casing will then be firmly seated into the bedrock surface to seal off the borehole from the overlying strata and the borehole will be flushed with clean water. A decontaminated core barrel to be used will be carefully inspected by the driller to ensure that all of the equipment is operating properly. An appropriate type of bit to produce optimum recovery for the bedrock type anticipated will be selected. It may be desirable to change bits depending on the rock types encountered. When production drops, worn out or damaged bits will be changed.

The core barrel will be lowered into the borehole and drill stem will be connected to the drill rig. Potable water will be used as the drilling fluid. The driller will place marks between 1 and 6 inches apart on the slide piston to monitor the rate of advancement of the core barrel. The core barrel will be advanced by controlling the rate of feed, rotation speed, and flow of drilling fluid.

In order to minimize core losses in soft, erodable rock; drilling will be restricted to short runs of 2 to 3 feet each; drilling pressure will be kept low [under 150 pounds per square inch (psi)]; feed pressure will be kept under 100 psi; and a split inner core barrel will be used. Return drilling water will be screened by WESTON personnel for VOCs using a PID or FID. Once the core barrel is advanced to the required depth or progress stops as a result of a blockage, the driller must stop the rotation, terminate the circulation of the drilling fluid, and raise the drill stem a few inches to break the rock core from the rock mass. The core barrel will be screened by WESTON for VOCs using a PID or FID as it is retrieved from the borehole. The driller will carefully open the core barrel and WESTON personnel will place the recovered rock core in rock core boxes. These procedures will be repeated until the desired depth is achieved.

The WESTON Geologist will then note the properties of the rock core on the boring log form or field log book. These properties include rock type description; attitude of bedding, cleavage, or foliation planes; attitude and degree of jointing, whether open or filled, as well as evidence of shearing, crushing, or faulting; degree of alteration or weathering; hardness; and rock quality determination (RQD). The RQD value (always shown as a percentage) is a modified computation of percent rock core recovery that reflects the relative frequency of discontinuities and the compressibility of the rock mass. The RQD is computed by measuring and summing all the pieces of sound rock (≥ 4 inches) in a core run and dividing this by the total core run length.

Following the completion of the coring procedures, a monitoring well is installed or the borehole will be plugged as described in the following section.

WESTON will record field measurements, monitoring well construction details, and comments on the boring log form or field log book.

9.3.3.2 Plugging and Abandoning the Borehole

To prevent the boreholes from serving as pathways for the downward migration of contaminants, boreholes in which monitoring wells are not installed will be plugged using a cement/bentonite mixture. The placement of the cement/bentonite mixture will be performed with the tremie pipe held in place at the base of the interval to be grouted until the upper surface of the grout is measured to be at its desired elevation within the borehole; upon which point the tremie pipe will be retracted. The cement/bentonite mixture will fill the borehole to 3 feet below ground surface. The remaining 3 feet will be filled with concrete creating a concrete cap. The volume of the cement/bentonite mixture placed in the borehole will be recorded by the driller and compared to the calculated volume of the borehole. The concrete cap will be marked with a piece of metal or iron pipe, and then covered by soil. The metal allows for easy location of the borehole in the future by a metal detector.

WESTON will record field measurements, monitoring well construction details, and comments on the boring log form or field log book.

9.3.4 Driven Well Method

Driven wells consist of a wellpoint (screen) that is attached to the bottom of a casing (riser). Wellpoints and risers may be made of galvanized steel, black iron, and stainless steel. Due to the ability of galvanized steel and black iron to leach metals into the groundwater, WESTON commonly uses stainless steel wellpoints and risers.

Typically 1-inch diameter stainless steel drive points are installed using a hand-operated slide hammer or sledge hammer. The stainless steel drive points consist of a short length of longitudinally slotted (typically 0.5 to 1 foot) or screened (typically 2 to 5 feet) section threaded to a steel riser pipe. At each drive-point location, an appropriate length of slotted or screened stainless steel is selected (based on the anticipated subsurface conditions), fitted with a steel drive cap, and driven to a depth equal to approximately 0.5 feet less than its total length with a hand operated slide hammer or sledge hammer. The steel drive cap is then removed and an appropriate length of steel riser pipe is threaded onto the top of the steel riser pipe and installation is continued using the slide hammer or sledge hammer. The slide hammer and drive cap will be periodically removed during driving to check the well for the presence of water. The process is continued until the desired depth is achieved.

The area around the well point will be excavated to a depth of approximately 2 feet to allow for the placement of a protective well casing. A surface seal at least 6 inches thick above the ground surface, with a diameter of at least 2 feet greater than the protective casing will be created around the well point. The bottom of the protective casing will be placed 2 feet below the ground surface. The annulus between the protective casing and the well point shall be filled with approximately 1 foot of sand to prevent damage to the well point from freezing conditions. A drain hole shall be placed in the protective casing slightly above the ground surface to prevent water from accumulating and freezing between the protective casing and well point. Well construction specifications may be modified in the field based on the depth of the water table.

9.4 Well Development

Well development will either be performed by the drilling subcontractor or WESTON. If well development is to be performed by the drilling subcontractor, the specifications are detailed in the RFP. Pumps and appropriate materials required to remove water from the well will be provided by the drilling subcontractor. The drilling subcontractor shall also be responsible for providing Department of Transportation (DOT)-approved 55-gallon drums with removable lids and gaskets to be used for containment of monitoring well development purge water and moving the drums to a designated staging area. The drilling subcontractor will not be responsible for storage and/or disposal of any drums which may be filled during the course of on-site activities.

If well development is to be performed by WESTON, then procedures will be detailed in the site-specific SQAPs. Prior to conducting well development activities the following procedures should be followed by WESTON:

- Coordinate site access and obtain the keys to the monitoring well security cap locks
- Obtain information on each well to be developed (i.e., drilling, method, well diameter, depth, screened interval, anticipated contaminants, etc.).
- Obtain a water level meter, air monitoring equipment, materials/supplies for decontamination, pH and electrical conductivity meters, thermometer, and stopwatch.
- Assemble containers for temporary storage of water produced during well development. Containers must be structurally sound, compatible with anticipated contaminants, and easy to manage in the field.

The development should be performed as soon as practical after the well is installed, but no sooner than 48 hours after grouting is completed. Dispersing agents, acids, or disinfectants should not be used to enhance development of the well. Since no grouting is necessary for well points, the well points can be developed immediately after installation. The following procedures should be followed to develop the monitoring wells:

- Assemble necessary equipment on a plastic sheet around the well.

- Record pertinent information in field logbook (personnel, time, location ID, etc.).

- Open the monitoring well, take initial measurements (e.g. head space air monitoring readings, water level, well depth, pH, temperature, and specific conductivity) and record results in the site logbook.

- Develop the well until the water is clear and appears to be free of sediment. Note the initial color, clarity, and odor of the water.

- All water produced by development in contaminated or suspected contaminated areas must be containerized. Clearly label each container with the location ID. Determination of the appropriate disposal method will be based on the first round of analytical results from each well.

- No water should be added to the well to assist development without prior approval by the site geologist. If a well cannot be cleaned of mud to produce formation water because the aquifer yields insufficient water, small amounts of potable water may be injected to clean up this poorly yielding well. This may be done by dumping in buckets of water. When most of the mud is out, continue development with formation water only. It is essential that at least five times the amount of water injected must be produced back from the well in order to ensure that all injected water is removed from the formation.

- Note the final color, clarity, and odor of the water.

- Measure the final pH, temperature, and specific conductance of the water and record in the field logbook.

- The following data will be recorded in the field logbook:
  - well designation (location ID)
  - date(s) of well installation
  - date(s) and time of well development
  - static water level before and after development
  - quantity of water removed and time of removal
  - type and size/capacity of pump and/or bailer used
  - description of well development techniques used

The following post operation procedures should be followed:

- Decontaminate all equipment.
- Containerize all discharge water from known or suspected contaminated areas and store containers of purge water produced during development in a safe and secure area.
- After the first round of analytical results have been received, determine and implement the appropriate purge water disposal method.
- Following development, lock all monitoring wells.

10.0 Handling and Preservation

Chemicals that may be used during the decontamination process include nitric acid, hexane, methanol, and isopropanol. These chemicals will be handled in accordance with the site-specific SQAPs and HASP.

Often, a primary object of the drilling program is to obtain representative lithologic or environmental samples. Lithologic samples are taken in order to determine the geologic or hydrogeologic regime at a site. The most common techniques for retrieving lithologic samples in unconsolidated formations are described below:

- Split spoon sampling, carried out continuously or at discrete intervals during drilling, is used to make a field description of the sample and create a log of each boring.
- Shelby tube sampling, is used when an undisturbed sample is required from clayey or silty soils, especially for geotechnical evaluation or chemical analysis
- Cuttings description is used when a general lithologic description and approximate depths are sufficient.

The most common techniques for retrieving lithologic sampling in consolidated formations are described below:

- Rock coring is carried out continuously or at discrete intervals during drilling and enables the Geologist to write a field description of the sample, create a log of each boring, and map occurrences and orientation of fractures.
- A description of cuttings is used when a general lithologic description and approximate depths are sufficient.

11.0 Sample Preparation and Analysis

This section is not applicable to this SOP.

12.0 Troubleshooting

All field screening instrumentation must be operated in accordance with operating instructions as supplied by the manufacturer, unless otherwise specified in the work plan. Equipment checkout and calibration activities must occur prior to sampling/operation, and they must be documented.

13.0 Data Acquisition, Calculations, and Data Reduction

13.1 Monitoring Well Installation Calculations

To maintain an open borehole using sand or water rotary drilling, the drilling fluid must exert a pressure greater than the formation pore pressure. Typical pore pressure for an unconfined aquifer is 0.433 psi/ft and for a confined aquifer is 0.465 psi/ft.

The calculation for determining the hydrostatic pressure of the drilling fluid is:

Hydrostatic Pressure (psi) = Fluid Density (lb/gal) x Height of Fluid Column (ft) x 0.052

The minimum grout volume necessary to grout a well can be calculated using:

Grout Vol (ft^3) = Vol of Borehole (ft^3) - Vol of Casing (ft^3) = $L (r_B^2 - r_C^2)$

where:

r_B = radius of boring (ft)
r_C = radius of casing (ft)
L = length of borehole to be grouted (ft)

13.2 Well Development Calculations

There are no calculations necessary to implement this procedure. However, if it is necessary to calculate the volume of the well, utilize the following equation:

Well volume = nr^2h (cf) [Equation 1]

where:

n = pi
r = radius of monitoring well (feet)

h	=	height of the water column (feet) [This may be determined by subtracting the depth to water from the total depth of the well as measured from the same reference point.]
cf	=	conversion factor (gal/ft^3) = 7.48 gal/ft^3 [In this equation, 7.48 gal/ft^3 is the necessary conversion factor, because 7.48 gallons of water occupy 1 ft^3]

Monitoring wells are typically 2 inches, 3 inches, 4 inches, or 6 inches in diameter. If the diameter of the monitoring well is known, a number of standard conversion factors can be used to simplify the equation above.

The volume, in gallons per linear foot, for various standard monitoring well diameters can be calculated as follows:

$$v = nr^2 (cf) \quad \text{[Equation 2]}$$

where:

v	=	volume in gallons per linear foot
n	=	pi
r	=	radius of monitoring well (feet)
cf	=	conversion factor (7.48 gal/ft^3)

For a 2-inch diameter well, the volume per linear foot can be calculated as follows:

$$\begin{aligned} v &= nr^2 (cf) \quad \text{[Equation 2]} \\ &= 3.14\ (1/12\ ft)^2\ 7.48\ gal/ft^3 \\ &= 0.1632\ gal/ft \end{aligned}$$

Remember that if you have a 2-inch diameter well, you must convert this to the radius in feet to be able to use the equation.

The volume per linear foot for monitoring wells of common size are as follows:

<u>Well Diameter (volume in gal/ft.)</u>

2 inches	0.1632
3 inches	0.3672
4 inches	0.6528
6 inches	1.4688

If you utilize the conversion factors above, Equation 1 should be modified as follows:

Well volume = (h)(v) [Equation 3]

where:

h	=	height of water column (feet)
v	=	volume in gallons per linear foot from Equation 2

13.3 Data Management and Records Management

Field observations made during monitoring well installation and well development will be recorded in a site logbook, boring logs, and/or field data sheets, including description of lithology and any deviations from the site-specific SQAP. Photographs will be taken to document site conditions. The location and direction from which photographs are taken will be noted in the field logbook, in accordance with the scope of work. Soil borings will be logged by the WESTON on-site geologist and boring logs will be prepared following site activities. Reports, site file memoranda, figures, tables, boring logs, etc. will be saved in site-specific Technical Direction Document (TDD) directories.

14.0 Quality Control and Quality Assurance Section

The following general QA procedures apply to monitoring well installation and well development:

- All data must be documented on standard well completion forms, field data sheets or within field/site logbooks.

- All instrumentation must be operated in accordance with operating instructions as supplied by the manufacturer, unless otherwise specified in the site-specific SQAP. Equipment checkout and calibration activities must occur prior to sampling/operation and they must be documented.

15.0 Reference Section

Roy F. Weston, Inc. December 1999. *Manual of Procedures for Shipping and Transporting Dangerous Goods.*

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STANDARD OPERATING PROCEDURE FOR MEASURING DEPTH TO GROUNDWATER

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2 May 2001

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1.0 Scope and Applicability

The purpose of this Standard Operating Procedure (SOP) is to describe the procedures by which Roy F. Weston, Inc. (WESTON®) personnel will determine the depth to groundwater in an open borehole, cased borehole, monitoring well, or piezometer.

Generally, water level measurements from boreholes, monitoring wells, or piezometers are used to construct potentiometric surface maps of the water table. Therefore, all water level measurements at a given site should be collected within a 24-hour period. Certain situations may necessitate that all water level measurements be taken within a shorter time interval. These situations may include:

- Magnitude of the observed changes between wells appears too large.
- Atmospheric pressure changes.
- Aquifers which are tidally influenced.
- Aquifers affected by river stage, impoundments, and/or unlined ditches.
- Aquifers stressed by intermittent pumping of production wells.
- Aquifers being actively recharged due to precipitation events.

2.0 Summary of Method

Working with decontaminated equipment, proceed from the least to the most contaminated wells. Open the well, remove the cap from the riser pipe, and monitor the headspace with an appropriate monitoring instrument to determine the presence of volatile organic compounds (VOCs).

A survey mark should be placed on the casing for use as a reference point for measurement. Many times the lip of the riser pipe is not flat. Another measuring reference should be located on the grout apron. The measuring point should be documented in the site logbook and on the groundwater level data form.

Lower the water level measurement device into the well until the water surface or bottom of casing is encountered. Measure the distance from the water surface to the reference point on the well casing and record it in the site logbook and/or on field data sheets. Remove the water level measurement device, decontaminate it as necessary, and replace the well cap.

Water levels in piezometers and monitoring wells should be allowed to stabilize for a minimum of 24 hours after well construction and development, prior to measurement. In low yield situations, recovery may take longer.

A level survey can be conducted to determine the ground surface and top of casing elevations at on-site groundwater wells. Elevations are references to the National Geodetic Vertical Datum (NGVD) to the closest 0.01 foot. If the NGVD Datum is not readily available, a local arbitrary datum of 100 feet will be used as the reference elevation. Ground surface and top of casing locations that are surveyed will be clearly marked and recorded in the field logbook.

3.0 Acronym List

DOT	-	Department of Transportation
EPA	-	U.S. Environmental Protection Agency
FID	-	Flame Ionization Detector
GPS	-	Global Positioning System
HASP	-	Health and Safety Plan
IATA	-	International Air Transport Association
IDW	-	Investigation-derived wastes
NGVD	-	National Geodetic Vertical Datum
OSHA	-	Occupational Safety and Health Administration
PID	-	Photoionization Detector
PPE	-	Personal Protective Equipment
PRP	-	Potentially Responsible Party
QA/QC	-	Quality Assurance/Quality Control
SOP	-	Standard Operating Procedure
SQAP	-	Sampling and Quality Assurance Plan
START	-	Superfund Technical Assessment and Response Team
VOC	-	Volatile Organic Compound
WESTON	-	Roy F. Weston, Inc.

4.0 Health and Safety Warnings

WESTON personnel performing work on hazardous waste sites will follow Occupational Safety and Health Administration (OSHA), U.S. Environmental Protection Agency (EPA), and specific health and safety procedures and protocols. WESTON personnel measuring depth to groundwater will also be performing tasks in accordance with site-specific health and safety plans, and site-specific SQAPs.

In order to ensure the safety of personnel while measuring depth to groundwater, the buddy system, periodic air monitoring, and caution will be used throughout field activities. To minimize risks due to chemical exposure, dermal and respiratory protection may be required if air monitoring equipment indicates that the environment is unsafe. Field activities will follow the site health and safety plan (HASP), which further addresses the safety considerations of the property. Hazards identified in or around the site may include physical hazards (slips, trips, and falls).

Decontamination wastes will be collected and secured on site. Separate containers will be used for the aqueous wastes and for flammable, non-chlorinated solvents (methanol and hexane) wastes. Proper personal protection will be worn during decontamination procedures and will include gloves, eye protection, and splash-resistant protective clothing. Off-site disposal of decontamination wastes and contaminated PPE will be conducted for disposal of investigation-derived wastes (IDW). Non-contaminated wastes will be tightly sealed, double-bagged, and disposed of appropriately.

5.0 Interferences

Problems associated with measuring depth to groundwater may include the following:

- The chalk used on steel tape water level meters may contaminate the well.
- Cascading water may obscure the water mark on the steel tape water level meters or cause it to be inaccurate.
- Many types of electric sounders use metal indicators at 5-foot intervals around a conducting wire. These intervals should be checked with a surveyor's tape to ensure accuracy.
- If there is oil present on the water, it can insulate the contacts of the probe on an electric sounder or give false readings due to thickness of the oil. Determining the thickness and density of the oil layer may be warranted, in order to determine the correct water level.
- Turbulence in the well and/or cascading water can make water level determination difficult with either an electric sounder or steel tape.
- An airline measures drawdown during pumping. It is only accurate to 0.5 foot unless it is calibrated for various "drawdowns".

6.0 Personnel Qualifications

Training of WESTON personnel will be provided to ensure that technical, operational, and quality requirements are understood. WESTON personnel are trained in-house and in-field to measure depth to groundwater. Training includes reviewing this SOP and other applicable SOPs and/or guidance documents, health and safety training, and "hands-on" experience with more experienced WESTON personnel.

7.0 Apparatus and Materials

There are a number of devices which can be used to measure groundwater levels, such as steel tape or airlines. The device should be adequate to attain an accuracy of 0.01 feet. The following equipment is needed to measure groundwater levels:

- Site-specific SQAPs.
- SOP for Measuring Depth to Groundwater.
- Safety equipment specified in the site HASP.
- Field map of site.
- Logbook.
- Field data sheets.

- Air monitoring equipment.
- Water level measurement device.
- Electronic water level indicator.
- Metal tape measure.
- Airline.
- Steel tape.
- Chalk.
- Ruler.
- Notebook.
- Paper towels.
- Decontamination solution and equipment.
- Groundwater level data forms.
- Decontamination fluids (supplies)/equipment (pump sprayers, brushes, etc.).
- Plastic sheeting (Visqueen).
- Plastic tubs.

8.0 Method Calibration

This section is not applicable to this SOP.

9.0 Procedures—Measuring Depth to Groundwater

The following procedures should be followed when conducting groundwater level measurements.

- Make sure water level measuring equipment is in good operating condition.

- If possible and where applicable, start at those wells that are least contaminated and proceed to those wells that are most contaminated.

- Clean all equipment entering the well by the following decontamination procedure:

  - Triple rinse equipment with deionized water.
  - Wash equipment with an Alconox solution followed by a deionized water rinse.
  - Rinse with an approved solvent (e.g., methanol, isopropyl alcohol, acetone) as per the work plan, if organic contamination is suspected.

- Place equipment on clean surface such as a Visqueen sheet.

- Remove locking well cap, note location, time of day, and date in the site logbook or on an appropriate groundwater level data form.

- Remove the well cap from the well riser pipe.

- If required by site-specific conditions, monitor headspace of the well with a photoionization detector (PID) or flame ionization detector (FID) to determine the presence of VOCs and record in site logbook.

- Lower electric water level measuring device or equivalent (i.e., permanently installed transducers or airline) into the well until water surface is encountered.

- Measure the distance from the water surface to the reference measuring point on the well riser pipe or protective casing and record in the field logbook. In addition, note that the water level measurement was from the top of the steel casing, top of the polyvinyl chloride (PVC) riser pipe, from the ground surface, or from some other position on the well head.

- The groundwater level data form should be completed as follows:

  - Site name
  - WESTON personnel's name taking field notes
  - Date (the date when the water levels are being measured)
  - Location (monitor well number and physical location)
  - Time (the military time at which the water level measurement was recorded)
  - Depth to water: the water level measurement in feet, or in tenths or hundreds of feet, depending on the equipment used
  - Comments: any information the field personnel feels to be applicable
  - Measuring point: marked measuring point on PVC riser pipe, protective steel casing, or concrete pad surrounding well casing from which all water level measurements for individual wells should be measured. This provides consistency in future water level measurements.

- Remove all downhole equipment, replace well cap and lock steel caps.

- Rinse all downhole equipment and store for transport to next well.

- Note any physical changes such as erosion or cracks in protective concrete pad or variation in total depth of well in field logbook and on field data sheets.

- Decontaminate all equipment as outlined in Step 3 above.

10.0 Handling and Preservation

This section is not applicable to this SOP.

11.0 Sample Preparation and Analysis

This section is not applicable to this SOP.

12.0 Troubleshooting

All field screening instrumentation must be operated in accordance with operating instructions as supplied by the manufacturer, unless otherwise specified in the work plan. Equipment checkout and calibration activities must occur prior to sampling/operation, and they must be documented.

13.0 Data Acquisition, Calculations, and Data Reduction

Field observations made during the field event will be recorded in a site logbook and/or field data sheets, including description of monitoring well locations and any deviations from the site-specific SQAP. The location and direction from which photographs are taken will be noted in the field logbook, in accordance with the scope of work.

14.0 Quality Assurance and Quality Control (QA/QC) Section

The following general QA/QC procedures apply:

- All groundwater elevation data and field observations must be documented in field logbooks or field data sheets.
- All instrumentation must be operated in accordance with operating instructions as supplied by the manufacturer, unless otherwise specified in the site-specific SQAP. Equipment checkout and calibration activities must occur prior to sampling /operation, and they must be documented.
- Each well should be measured at least twice in order to compare results.

SOP Number: RFW/R10-018, Revision 0
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STANDARD OPERATING PROCEDURE FOR HEADSPACE SCREENING

Prepared by:

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1 May 2001

APPROVALS

Reviewed by: [signature] Date: June 1, 2001
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Approved by: [signature] Date: 06/01/2001
Quality Assurance Officer

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1.0 Scope and Applicability

The purpose of this Standard Operating Procedure (SOP) is to describe the procedures by which Roy F. Weston, Inc. (WESTON®) personnel will collect headspace readings from jarred or bagged soil samples. The purpose for the headspace screening will be detailed in site-specific Sampling and Quality Assurance Plans (SQAPs) and may include determining whether volatile organic compound (VOC) vapors are present in specific soil samples, determining which soil samples have the greatest concentrations of VOC vapors in order to make a selection for laboratory analysis, or determining if the contaminants are present at concentrations that may present a risk to public health, welfare, or the environment.

2.0 Summary of Method

Screening of the sample headspace is done using a photoionization detector (PID) or flame ionization detector (FID), which measures the total VOC vapor concentration within the soil sample. The soil sample is placed in the jar (filling it approximately 75%) leaving a void space in the top and the mouth of the jar is covered with foil prior to fastening the cap. The jar is then shaken so as to allow any VOC vapors within the soil to fill the void space. The cap to the jar is then unscrewed and the probe of the PID or FID is pierced through the foil to collect a headspace reading. Alternatively a plastic Ziplock baggie may be used to contain the soil sample for headspace screening. Soil samples (surface and subsurface) may be collected using a variety of methods and equipment. Techniques for collecting surface and subsurface soil samples are discussed in a separate SOP entitled, *Standard Operating Procedure for Surface and Subsurface Soil Sampling*. This SOP should be reviewed prior to conducting screening via the headspace method.

3.0 Acronym List

EPA	-	U.S. Environmental Protection Agency
ERRS	-	Emergency Rapid Response Services
FID	-	Flame ionization detector
GPS	-	Global Positioning System
HASP	-	Health and Safety Plan
OSHA	-	Occupational Safety and Health Administration
PID	-	Photoionization Detector
PPE	-	Personal Protective Equipment
PRP	-	Potentially Responsible Party
QA/QC	-	Quality Assurance/Quality Control
RFP	-	Request for Proposal
SOP	-	Standard Operating Procedure
SQAP	-	Sampling and Quality Assurance Plan
START	-	Superfund Technical Assessment and Response Team
TDD	-	Technical Direction Document
VOC	-	Volatile Organic Compound
WESTON	-	Roy F. Weston, Inc.

4.0 Health and Safety Warnings

WESTON personnel performing work on hazardous waste sites will follow Occupational Safety and Health Administration (OSHA), U.S. Environmental Protection Agency (EPA), and WESTON specific health and safety procedures and protocols. WESTON personnel conducting on-site headspace screening activities will also be performing tasks in accordance with EPA-approved SQAPs.

In order to ensure the safety of personnel during screening activities, the buddy system, periodic air monitoring, and caution will be used throughout field activities. To minimize risks due to chemical exposure, dermal and respiratory protection may be required if air monitoring equipment indicates that the environment is unsafe. Field activities will follow the site HASP, which further addresses the safety considerations of the property. Hazards identified in or around the site may include physical hazards (slips, trips, and falls). Additional potential hazards exist in association with drilling and excavation activities; therefore, WESTON and its subcontractors will utilize the WESTON Drilling Safety Guide and will follow industry standards and protocols for all activities involving drill rigs or similar apparatus for the purpose of soil boring and excavation activities.

5.0 Interferences

Some interferences or potential problems associated with headspace screening include cold weather and improper sample preparation. Cold weather can sometimes interfere with the capability of the PID or FID to produce accurate readings. If possible, keep the monitoring equipment in a heated room or vehicle prior to use. Improper sample preparation can involve filling the jar or baggie too much to allow for void space, covering the mouth with torn foil allowing VOC vapors to escape, or inadequate homogenization of the samples where required, resulting in variable, non-representative results.

6.0 Personnel Qualifications

Training of WESTON personnel will be provided to ensure that technical, operational, and quality requirements are understood. WESTON personnel are trained in-house and in-field to conduct headspace screening activities. Training includes reviewing this SOP and other applicable SOPs and/or guidance documents; health and safety training; and "hands-on" experience conducting screening activities with more experienced WESTON personnel, and performing instrument calibrations.

7.0 Apparatus and Materials

Equipment/materials for headspace screening includes, but is not limited to, the following:

- Site-specific SQAP.
- Field map of site.
- Logbook.
- Camera and film.

- Standard Operating Procedure for Headspace Screening.
- Safety equipment specified in the site HASP.
- PID or FID.
- Calibration gases.
- Aluminum foil.
- Sample containers (jars or baggies).

8.0 Method Calibration

This section is not applicable to this SOP.

9.0 Headspace Reading Collection

9.1 Headspace Screening Procedure

The following procedure should be followed when conducting on-site screening activities.

- Fill one clean glass jar half-way with the sample to be analyzed. Quickly cover the open top with one or two sheets of clean aluminum foil and subsequently apply screw cap to tightly seal the jar. One eight ounce (oz.) (approximately 500 milliliters) soil or "mason" type jars are preferred; jars less than 8-oz. total capacity (approximately 250 milliliters), should not be used.

- Allow headspace development for at least 10 minutes. Vigorously shake the jar for 15 seconds both at the beginning and end of the headspace development period. Where ambient temperatures are below 32° F (0° C), headspace development should be conducted within a heated vehicle or building.

- Following headspace development, remove the screw lid/expose foil seal. Quickly puncture foil seal with instrument sampling probe, to a point about one-half of the headspace depth. Exercise care to avoid uptake of water droplets or soil particulates.

  As an alternative, syringe withdrawal of a headspace sample with subsequent injection to instrument probe or septum-fitted inlet is acceptable contingent upon verification of methodology accuracy using a test gas standard.

- Following probe insertion through foil seal and/or sample injection to the probe, record highest meter response as the jar headspace concentration. Maximum response should occur between 2 and 5 seconds. Erratic meter response may occur at high organic vapor concentrations or conditions of elevated headspace moisture, in which case headspace data should be discounted.

- PID field instruments shall be operated and calibrated to yield "total organic vapors" in ppm (v/v) as benzene. PID instruments must be operated with a 10.2 eV (+/-) lamp source. Operations, maintenance, and calibration shall be performed in accordance with the manufacturer's specifications. For headspace analysis, instrument calibration shall be checked/adjusted no less than once every 10 analyses, or daily, whichever is greater.

- Instrumentation with digital (LED/LCD) displays may not be able to discern maximum headspace response unless equipped with a "maximum hold" feature or strip-chart recorder.

9.2 Baggie Headspace Screening Procedure

- Following headspace development, quickly puncture the bag with the instrument sampling probe, to a point about one-half of the headspace depth. Alternatively, you can also open a corner of the bag's seal, insert the instrument sampling probe to about one-half of the headspace depth, and seal the bag tightly around the probe to take the reading. While taking the reading, move the soil around from outside the bag to break any leftover soil clumps. Exercise care to avoid uptake of water droplets or soil particulates into the probe as this will foul the lamp.

  As an alternative to directly inserting the probe into the bag, syringe withdrawal of a headspace sample with subsequent injection to instrument probe or septum-fitted inlet is acceptable contingent upon verification of methodology accuracy using a test gas standard.

- Following probe insertion through the bag or bag seal, record the highest meter response as the bag headspace concentration. Maximum equipment response should occur between 2 and 5 seconds. Erratic meter response may occur at high organic vapor concentrations or conditions of elevated headspace moisture, in which case headspace data should be discounted.

- PID field instruments shall be operated and calibrated to yield "total organic vapors" in ppm (v/v) as benzene. PID instruments must be operated with a 10.2 eV (+/-) lamp source. Operations, maintenance, and calibration shall be performed in accordance with the manufacturer's specifications. For headspace analysis, instrument calibration shall be checked/adjusted no less than once every 10 analyses, or daily, whichever is greater.

- Instrumentation with digital (LED/LCD) displays may not be able to discern maximum headspace response unless equipped with a "maximum hold" feature or strip-chart recorder.

10.0 Handling and Preservation

This section is not applicable to this SOP.

11.0 Sample Preparation and Analysis

This section is not applicable to this SOP.

12.0 Troubleshooting

All field screening instrumentation must be operated in accordance with operating instructions as supplied by the manufacturer, unless otherwise specified in the work plan. Equipment checkout and calibration activities must occur prior to sampling/operation, and they must be documented.

13.0 Data Acquisition, Calculations, and Data Reduction

Field observations made during the field event will be recorded in a site logbook and/or field data sheets, including description of soil sample screening locations and any deviations from the site-specific SQAP. The location and direction from which photographs are taken will be noted in the field logbook, in accordance with the scope of work.

14.0 Quality Assurance and Quality Control (QA/QC) Section

The following general QA/QC procedures apply:

- All data must be documented on standard chain of custody forms, field data sheets, or within site logbooks.
- All instrumentation must be operated in accordance with operating instructions as supplied by the manufacturer, unless otherwise specified in the site-specific SQAP. Equipment checkout and calibration activities must occur prior to sampling/operation, and they must be documented.

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STANDARD OPERATING PROCEDURE FOR SURFACE AND SUBSURFACE SOIL SAMPLING

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13 April 2001

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1.0 Scope and Applicability

The purpose of this Standard Operating Procedure (SOP) is to describe the procedures by which Roy F. Weston, Inc. (WESTON®) personnel will collect representative surface and subsurface soil samples. The purposes for the collection and analysis of soil samples will be detailed in site-specific Sampling and Quality Assurance Plans (SQAPs) and may include: determining whether concentrations of hazardous substances in soils exceed established action levels, confirming or identifying hazardous substances that may have impacted the environment, determining if contaminants are migrating off site, or determining if the contaminants are present at concentrations that may present a risk to public health, welfare, or the environment.

2.0 Summary of Method

Soil samples (surface and subsurface) may be collected using a variety of methods and equipment. The methods and equipment used are dependent on the depth of the desired sample, the type of sample required (disturbed versus undisturbed), and the type of soil. Near-surface soils (0 - 2 feet) may be easily sampled using a trowel, scoop, or spade. Sampling at greater depths may be performed using a hand auger, Geoprobe, drill rig split spoon, or excavator.

3.0 Acronym List

cc	-	Cubic Centimeters
CLP	-	Contract Laboratory Program
DAS	-	Delivery of Analytical Services
DOT	-	Department of Transportation
Dupl	-	Duplicate
EPA	-	U.S. Environmental Protection Agency
ERRS	-	Emergency Rapid Response Services
FID	-	Flame Ionization Detector
ft_2	-	Square Foot
GPS	-	Global Positioning System
HASP	-	Health and Safety Plan
HCl	-	Hydrochloric Acid
HNO_3	-	Nitric Acid
IATA	-	International Air Transport Association
ml	-	milliliter
MS/MSD	-	Matrix Spike/Matrix Spike Duplicate
NaOH	-	Sodium Hydroxide
OSHA	-	Occupational Safety and Health Administration
PE	-	Performance Evaluation
pest/PCB	-	Pesticide/Polychlorinated Biphenyl
PID	-	Photoionization Detector
PPE	-	Personal Protective Equipment

ppm	-	Parts per million
PRP	-	Potentially Responsible Party
QAPP	-	Quality Assurance Project Plan
QA/QC	-	Quality Assurance/Quality Control
RFP	-	Request for Proposal
SDG	-	Sample Delivery Group
SOP	-	Standard Operating Procedure
SQAP	-	Sampling and Quality Assurance Plan
START	-	Superfund Technical Assessment and Response Team
SVOC	-	Semivolatile Organic Compound
TDD	-	Technical Direction Document
VOA	-	Volatile Organic Analysis
VOC	-	Volatile Organic Compound
WESTON	-	Roy F. Weston, Inc.

4.0 Health and Safety Warnings

WESTON personnel performing work on hazardous waste sites will follow Occupational Safety and Health Administration (OSHA), Environmental Protection Agency (EPA), and WESTON specific health and safety procedures and protocols. WESTON personnel conducting on-site soil sampling activities will also be performing tasks in accordance with EPA-approved sampling QAPPs.

In order to ensure the safety of personnel during sampling activities, the buddy system, periodic air monitoring, and caution will be used throughout field activities. To minimize risks due to chemical exposure, dermal and respiratory protection may be required if air monitoring equipment indicates that the environment is unsafe. Field activities will follow the site HASP, which further addresses the safety considerations of the property. Hazards identified in or around the site may include physical hazards (slips, trips, and falls). Additional potential hazards exist in association with drilling and excavation activities; therefore, WESTON and its subcontractors will utilize the WESTON Drilling Safety Guide and will follow industry standards and protocols for all activities involving drill rigs or similar apparatus for the purpose of soil boring and excavation activities.

For any field assignments involving the collection of subsurface samples, excavation, or any other type of intrusive activities, it is a legal requirement to call the appropriate utility clearance center before beginning any intrusive activities on site.

The samples collected at the site will be transported to predesignated Contract Laboratory Program (CLP) and/or Delivery of Analytical Services (DAS) laboratories according to either Department of Transportation (DOT) Hazardous Materials Regulations or International Air Transport Association (IATA) Dangerous Goods Regulations, or hand-delivered to the predesignated laboratories. Samples will be transported in a manner that will maintain their integrity, as well as protect against detrimental effects from sample breakage or leakage. The Roy F. Weston, Inc. *Manual of Procedures for Shipping and Transporting Dangerous Goods* will be followed whenever samples are shipped.

Decontamination wastes will be collected and secured on site. Separate containers will be used for the aqueous wastes and for flammable, non-chlorinated solvents (methanol and hexane) wastes. Proper personal protection will be worn during decontamination procedures and will include gloves, eye protection, and splash-resistant protective clothing. Off-site disposal of decontamination wastes and contaminated Personal Protective Equipment (PPE) will be conducted for disposal of investigation-derived wastes. Non-contaminated wastes will be tightly sealed, double-bagged, and disposed of appropriately.

5.0 Interferences

Some interferences or potential problems associated with soil sampling include cross-contamination of samples and improper sample collection. Cross-contamination problems can be eliminated or minimized through the use of dedicated sampling equipment. If this is not possible or practical, then decontamination of sampling equipment is necessary. Improper sample collection can involve using contaminated equipment, disturbance of the matrix resulting in compaction of the sample, or inadequate homogenization of the samples where required, resulting in variable, non-representative results.

6.0 Personnel Qualifications

Training of WESTON members will be provided to ensure that technical, operational, and quality requirements are understood. WESTON personnel are trained in-house to conduct surface and subsurface soil sampling activities. Training includes reviewing this SOP and other applicable SOPs and/or guidance documents; health and safety training; and "hands-on" experience conducting sampling activities with more experienced WESTON personnel, and performing instrument calibrations. Operation of the Geoprobe is performed by more qualified personnel who have received training by the manufacturer and have assisted qualified Geoprobe operators during several sampling events. Subsurface soil sampling performed by split spoons on a drill rig are monitored by a WESTON Geologist or other qualified member having extensive experience in drilling operations.

7.0 Apparatus and Materials

Equipment/materials for collecting soil samples includes, but is not limited to, the following:

- Site-specific SQAPs
- Standard Operating Procedure for Surface and Subsurface Soil Sampling
- Safety equipment specified in the site HASP
- Field map of site
- Log book
- Field data sheets (e.g. boring logs, soil description sheets, etc.)
- Graph paper
- Tape measure
- Survey stakes
- Compass

- Survey stakes or flags (white)
- Camera and film
- Continuous flight (screw) auger
- Continuous flight auger extension rods
- Spatula, scoops, or trowel
- Bucket auger
- Post hole auger
- Thin-wall tube sampler
- T-handle
- Post hole auger
- Stainless steel homogenization bucket or bowl
- Spade or shovel
- Sampling jars
- Spade or shovel
- Decontamination fluids (supplies)/equipment (pump sprayers, brushes, etc.)
- Plastic sheeting (Visqueen)
- Plastic tubs
- Sealable plastic bags
- Labels
- Chain-of-custody forms and seals
- Coolers and ice
- Vermiculite
- Strapping tape

7.1 Reagents

Preservation solutions for rinsate blanks include the following: nitric acid (HNO_3), sodium hydroxide (NaOH), and hydrochloric acid (HCl).

8.0 Method Calibration

This section is not applicable to this SOP.

9.0 Sample Collection

9.1 Preparation

Following EPA approval of the site-specific QAPPs, and prior to conducting sampling activities, a pre-sampling meeting will be held by WESTON personnel to discuss the proposed sampling strategy and site health and safety issues. During the pre-sampling meeting, the Site Leader will discuss the site history, contaminants of concern, sampling methodology, individual responsibilities, sample shipment or delivery, health and safety issues, and lines of communication anticipated during the sampling event.

Prior to mobilizing to the site to conduct sampling activities, the Site Leader will fill out an equipment/supply list and transmit the list to the WESTON Equipment Stores technician one week prior to the sampling event. Necessary sampling equipment, sample containers, PPE, and vehicles are therefore reserved. CLP and/or DAS laboratories are also procured or secured one week prior to the sampling by the Lead Chemist.

9.2 Surface Soil Sample Collection

Prior to conducting any on-site activities, WESTON will review and sign the site-specific HASP. The WESTON field team will establish a command post upwind of suspected source areas, if possible. WESTON will perform calibration checks of air monitoring instruments and document background ambient air monitoring levels. The samplers will decontaminate the sampling equipment. Decontamination will be conducted in accordance with the HASP, applicable SOPs, and/or the RFPs for drilling or excavation services. Decontamination generally consists of an alconox and water wash followed by a distilled water rinse, followed by an isopropanol rinse, followed by a de-ionized water final rinse, and air drying. Additionally, where high concentrations of specific substances are anticipated, chemicals such as methanol, hexane, and/or HNO_3 may be used in the decontamination process. In cases where a driller has been procured to advance borings and install monitoring wells, the drilling equipment utilized for the completion of soil borings and installation of monitoring wells will be steam-cleaned before and after daily sampling activities and at each sample location utilizing a pressure washer, then further decontaminated in accordance with the decontamination procedure specified in the site-specific sampling plan and HASP. Excavation equipment will also be decontaminated before and after daily sampling activities and at each sample location utilizing a pressure washer, then further decontaminated in accordance with the decontamination procedure specified in the site-specific sampling plan and HASP. Equipment decontamination fluids, and PPE generated during sampling activities will be containerized and disposed appropriately based on the results of laboratory analyses of samples collected.

The number of surface soil samples and the sample locations are described in the approved site-specific QAPP. Under the Removal Program, surface soil samples are generally collected to determine if any hazardous substances are present on site at such concentrations that a removal action is warranted; to determine the extent of contamination; or to ensure that clean up levels are achieved during removal actions. Under the Removal Program, surface soil samples are generally collected at a depth ranging between 0 and 6 inches. Under the Site Assessment Program, surface soil samples are generally collected to determine if concentrations of hazardous substances exceed background levels and can be used to define areas of observed contamination under the Hazard Ranking System. Under the Site Assessment Program, surface soil samples are generally collected at depths ranging between 0 and 24 inches.

9.2.1 Grab Sampling

Surface soil samples will be collected over a surface area of 1 square foot (ft^2) per sample station. Prior to any sample collection, any extraneous material considered to be not relevant for sample analysis will be removed from the top layer of the sample with a pre-cleaned spade. A thin layer of soil from the area which came in contact with the spade will be removed and discarded using a pre-cleaned, stainless steel scoop, plastic spoon, or trowel. The following section discusses collecting surface soil samples for typical parameters.

VOC Sampling - The proper collection of a sample for VOC analysis requires minimal disturbance of the sample to minimize loss of volatile compounds from the sample. If volatile organic analysis is to be performed, soil samples will be collected first using a dedicated sampling spatula and placed directly into the appropriate size, prelabelled glass sample container. The samples will then be preserved by placing the sample container in a cooler with ice.

To increase the data reliability and reproducibility, it is desirable to manually homogenize the soil sample. After the VOC fraction of soil is collected, additional soil samples will be placed into a stainless-steel bowl or other appropriate homogenization container, and mixed thoroughly to obtain a homogenous sample representative of the entire sampling interval. A dedicated sampling spatula will be used to collect the sample material and place it into the appropriate sample container (preferably a wide-mouth container). Dedicated spatulas are used to prevent the possibility of cross-contamination between sample stations as well as to eliminate the need for any decontamination procedures. The container cap will then be secured, and the sample will be preserved by immediately placing containers in a cooler with ice.

In cases where split samples will be collected, an adequate amount of sample volume must be homogenized to account for the extra samples. Split samples will be used in situations where confirmation samples will be submitted to an analytical laboratory to verify on-site screening results, or an aliquot is requested by the potentially responsible party (PRP). The following section discusses collecting surface soil samples for typical parameters following homogenization of the sample.

Semivolatile Organic Compound (SVOC) Sampling - Surface soil samples will be collected using a dedicated sampling spatula as described above and placed into the appropriate size, prelabelled glass sample container. The samples will then be preserved by placing the sample container in a cooler with ice.

Pesticides/Polychlorinated Biphenyl (Pest/PCB) Sampling - Surface soil samples will be collected using a dedicated sampling spatula as described above and placed into the appropriate size, prelabelled glass sample container. The samples will then be preserved by placing the sample container in a cooler with ice.

Metals Sampling - Surface soil samples will be collected using a dedicated sampling spatula as described above and placed into the appropriate size, prelabelled sample container. The samples will then be preserved by placing the sample container in a cooler with ice.

Cyanide Sampling - Surface soil samples will be collected using a dedicated sampling spatula as described above and placed into the appropriate size, prelabelled sample container. The samples will then be preserved by placing the sample container in a cooler with ice.

Asbestos Sampling - Discrete soil samples will be collected from the homogenized sample using a dedicated sampling spatula as described above and placed into the appropriate size, prelabelled sample container.

9.2.2 Composite Sampling

Compositing samples is a useful technique to provide an average concentration of contaminants over a certain number of sampling points. The technique reduces both the number of required laboratory analyses and the sample variability. If sampling points are non-homogeneous, compositing dilutes high concentration aliquots; therefore, detection limits should be considered carefully when choosing the number of aliquots to composite (the compositing factor). The compositing factor (e.g., 3 to 1; 10 to 1) and the aliquots selected for inclusion in the compositing factor will be determined by EPA prior to sampling and will be recorded on the chain-of-custody documentation (e.g., composite, sampling stations 1-4) and in the site-specific QAPP. Detection limits need not be considered if the composite area is assumed to be homogeneous in concentration.

Compositing requires that each discrete aliquot be the same in terms of volume or weight, and that each of the aliquots be thoroughly homogenized. The detection limit of the analysis to be performed and the selected action level must be considered when choosing a compositing factor for non-homogeneous sample points. For example, if the chosen action level is 10 parts per million (ppm) in the soil and five aliquots are composited, then the action limit of the composite is 10 ppm divided by five, or 2 ppm. The detection limit of the analysis must be 2 ppm or lower in order to determine if the action limit has been exceeded in any one aliquot.

Sample aliquots of equal volume or weight will be manually homogenized inside of a stainless steel bowl using a stainless steel scoop or inside of a disposable pan using a disposable scoop. The sample is then quartered and split five times or until the sample is thoroughly homogenized. The homogenized sample is then placed into the appropriate size, prelabelled container (preferably a wide-mouth container) for each analyses to be performed. The container cap will then be secured and the sample will be preserved by immediately placing containers in a cooler with ice.

Compositing is **not** recommended when/where VOCs are the contaminants of concern. Homogenization will result in the potential loss of the target compounds. If homogenization is required, it will be done on samples that are preserved in the field. Equal volumes (ccs) of soil will be placed in the same pre-preserved jar.

9.3 Subsurface Soil Sample Collection

The number of subsurface soil samples, sample locations, and depths are described in the approved site-specific QAPPs. Under the Removal Program, subsurface soil samples are generally collected to determine if any hazardous substances are present on site at such concentrations that a removal action is warranted; to determine the extent of contamination; or to ensure that clean up levels are achieved during removal actions. Subsurface soil samples discussed in this section are those samples collected at depths greater than 6 inches. Under the Site Assessment Program, subsurface soil samples are collected to identify potential sources that may be used to determine attribution. Subsurface samples are those collected at depths greater than 2 feet.

The WESTON field team will establish a command post upwind of suspected source areas, if possible. WESTON will perform calibration checks of air monitoring instruments and document background ambient air monitoring levels. The samplers will decontaminate the sampling equipment. Decontamination will be conducted in accordance with the HASP, applicable SOPs, and/or the RFP for drilling or excavation services. Decontamination generally consists of an alconox and water wash followed by a distilled water rinse, followed by an isopropanol rinse, followed by a de-ionized water final rinse, and air drying. Additionally, where high concentrations of specific substances are anticipated, reagents such as methanol, hexane, and/or nitric acid may be used in the decontamination process. In cases where a driller has been procured by WESTON to advance borings and install monitoring wells, the drilling equipment utilized for the completion of soil borings and installation of monitoring wells will be steam-cleaned before and after daily sampling activities and at each sample location utilizing a pressure washer, then further decontaminated in accordance with the decontamination procedure specified in the site-specific sampling plan and HASP. Excavation equipment will also be decontaminated before and after daily sampling activities and at each sample location utilizing a pressure washer, then further decontaminated in accordance with the decontamination procedure specified in the site-specific sampling plan and HASP. Equipment decontamination fluids, and PPE generated during sampling activities will be containerized and disposed appropriately based on the results of laboratory analyses of samples collected.

Subsurface soil samples will be collected over a surface area within a 6-inch radius around the sample point per sample station. Prior to any sample collection, the surface area at the sample location will be cleared of any extraneous material considered to be not relevant for sample analysis. It may be advisable to remove the first 3 inches of surface soil from the approximately 6-inch radius around the sampling location.

9.3.1 Sample Collection Procedures for Auger and Thin-Wall Sampling

This system consists of an auger, a series of extensions, a "T" handle, and a thin-wall tube sampler. The auger is used to bore a hole to a desired sampling depth, and is then withdrawn. The sample may be collected directly from the auger. If a core sample is to be collected, the auger tip is then replaced with a thin-wall tube sampler. The system is then lowered down the borehole, and driven into the soil at the completion depth. The system is withdrawn and the core collected from the thin-wall tube sampler.

Several types of augers are available. These include the following: bucket, continuous flight (screw), and posthole augers. Bucket augers are better for direct sample recovery since they provide a large volume of sample in a short time. When continuous flight augers are used, the sample can be collected directly from the flights, which are usually at 5-feet intervals. The continuous flight augers are satisfactory for use when a composite of the complete soil column is desired. Posthole augers have limited utility for sample collection as they are designed to cut through fibrous, rooted, swampy soil.

The area to be sampled is cleared of any surface debris (e.g., twigs, rocks, litter). It may be advisable to remove the first 3 to 6 inches of surface soil for an area approximately 6 inches in radius around the sampling location. When clearing has been completed, the assembled auger is bored into the soil. The sampler begins augering, periodically removing accumulated soils onto a plastic sheet spread near the hole. This prevents accidental brushing of loose material back down the borehole when removing the auger or adding drill rods. It also facilitates refilling the hole, and avoids possible contamination of the surrounding area.

Upon reaching the desired sampling depth, the auger is slowly and carefully removed from the boring. When sampling directly from the auger, the sample is collected after the auger is removed from the boring. Once removed from the bore hole, the top inch of the sample core is removed and discarded. The remaining core is placed into a stainless steel bowl (or disposable pan) where it is homogenized **(except for VOCs)** using a stainless steel (or disposable) scoop. Any extraneous material not considered to be relevant for analysis is removed from the sample during homogenization. The sample is then placed into the appropriate size, prelabelled sample containers (preferably wide-mouthed) for each analysis to be performed. The container cap(s) will then be secured, and the samples will be preserved by immediately placing the containers in a cooler on ice. If VOC analysis is to be performed, soil samples will be collected directly from the auger using a dedicated sampling spatula and placed directly into the appropriate size, prelabelled glass sample container. The samples will then be preserved by placing the sample container in a cooler with ice.

To increase the data reliability and reproducibility, it is desirable to manually homogenize the soil sample. After the VOC fraction of soil is collected, additional soil samples will be placed into a stainless-steel bowl or other appropriate homogenization container, and mixed thoroughly to obtain a homogenous sample representative of the entire sampling interval. A dedicated sampling spatula will be used to collect the sample material and place it into the appropriate sample container (preferably a wide-mouth container). Dedicated spatulas are used to prevent the possibility of cross-contamination between sample stations as well as to eliminate the need for any decontamination procedures. The container cap will then be secured, and the sample will be preserved by immediately placing containers in a cooler with ice.

In cases where split samples will be collected, an adequate amount of sample volume must be homogenized to account for the extra samples. Split samples will be used in situations where confirmation samples will be submitted to an analytical laboratory to verify on-site screening results, or an aliquot is requested by the PRP. The following section discusses collecting surface soil samples for typical parameters following homogenization of the sample.

<u>SVOC Sampling</u> - Surface soil samples will be collected using a dedicated sampling spatula as described above and placed into the appropriate size, prelabelled glass sample container. The samples will then be preserved by placing the sample container in a cooler with ice.

<u>Pest/PCBs Sampling</u> - Surface soil samples will be collected using a dedicated sampling spatula as described above and placed into the appropriate size, prelabelled glass sample container. The samples will then be preserved by placing the sample container in a cooler with ice.

<u>Metals Sampling</u> - Surface soil samples will be collected using a dedicated sampling spatula as described above and placed into the appropriate size, prelabelled sample container. The samples will then be preserved by placing the sample container in a cooler with ice.

<u>Cyanide Sampling</u> - Surface soil samples will be collected using a dedicated sampling spatula as described above and placed into the appropriate size, prelabelled sample container. The samples will then be preserved by placing the sample container in a cooler with ice.

<u>Asbestos Sampling</u> - Discrete soil samples will be collected from the homogenized sample using a dedicated sampling spatula as described above and placed into the appropriate size, prelabelled sample container.

To use the thin-wall tube sampler, the auger tip is removed from drill rods and replaced with a pre-cleaned thin-wall tube sampler. The proper cutting tip is installed, and the tube sampler is carefully lowered down the borehole. The tube sampler is gradually forced into the soil. Care should be taken to avoid scraping the borehole sides. Hammering the drill rods to facilitate coring should be avoided as the vibrations may cause the boring walls to collapse. The tube sampler is removed, the drill rods unscrewed, and the cutting tip and the core removed from the device. The top of the core (approximately 1 inch), is discarded as this represents material collected before penetration of the layer of concern. The remaining core is placed into the appropriate labeled sample container(s).

Procedures for collecting samples for VOCs analysis, as well as other parameters, are similar to those described in the preceding section. Procedures for homogenizing soil samples, and collecting split and composite subsurface soil samples are also similar to those described in the preceding section.

If another sample is to be collected in the same hole, but at a greater depth, the auger bit is reattached to the drill and assembly, and the process is repeated, making sure to decontaminate the auger and tube sampler between samples. The boring is then abandoned according to applicable state regulations. Generally, shallow holes (less than 2 feet deep) can simply be backfilled with the removed soil material.

9.3.2 Sample Collection Procedures for Split Spoon Sampling

During the advancement of borings, split spoon sampling is one of the standard ways of collecting subsurface samples in unconsolidated materials. WESTON procures the services of a qualified driller via an RFP to perform this service. The RFP details the Scope of Work for the site and is divided into technical, administrative, health and safety, and general requirements. Since geologic information is recorded during this activity, a WESTON Geologist or qualified member will be assigned to the project.

The number of subsurface soil samples, sample locations, and depths are described in the site-specific QAPP. Prior to conducting any on-site activities, WESTON will review and sign the site-specific HASP. The WESTON field team will establish a command post upwind of suspected source areas, if possible. WESTON will perform calibration checks of air monitoring instruments and document background ambient air monitoring levels. The samplers will decontaminate the sampling equipment. Decontamination will be conducted in accordance with the HASP, applicable SOPs, and the RFP for drilling services. Decontamination generally consists of an alconox and water wash followed by a distilled water rinse, followed by an isopropanol rinse (for visibly or otherwise obviously contaminated samples), followed by a de-ionized water rinse.

Decontamination and containment materials will be supplied by the drilling subcontractor and included in the proposal. Drilling activities will be organized to minimize contamination of equipment, and the drilling subcontractor will be responsible for decontaminating all equipment prior to use at the site. The drilling subcontractor will be responsible for decontaminating the split spoons, after each boring and upon leaving an exclusion (i.e., potentially contaminated) zone. A vehicle and equipment decontamination area will be established by the drilling subcontractor. The Subcontractor will be required to follow WESTON's instructions for the proper decontamination of vehicles and equipment. Decontamination water will be collected in drums, provided by the drilling subcontractor, at the vehicle and equipment decontamination area for subsequent disposal.

Decontamination of the drill rigs and accessories between borings will consist of removing loose soil from the tracks, augers, casing, and drill rods and rinsing by using a steam and/or pressure washer equipped with an intermittent cleaning material siphon. Non-phosphate detergent solution will be used as a primary cleaning agent, and clean rinse water will follow. All extracted materials will be decontaminated by the drilling subcontractor prior to disposal with the steam and/or pressure washer.

Additionally, split spoon sampling devices will be rinsed between samples using non-phosphate detergent followed by a clean water rinse. All decontamination rinsate will be containerized in 55-gallon steel drums or a larger tank. The drilling subcontractor shall be responsible for providing all necessary decontamination materials, including a water supply (minimum of 500 gallons).

Core samples (of a 2-foot length) are collected at intervals of 5 feet, beginning at the 0-foot to 2-foot interval and thereafter (i.e. 5 to 7 feet, 10 to 12 feet, 15 to 17 feet, etc.). Prior to any sample collection, the surface area at the sample location will be cleared of any extraneous material considered to be not relevant for sample analysis. Generally, a 2-inch outside diameter, 2-foot long split spoon (with a spoon trap) is driven by a 140-pound weight dropped through a 30-inch interval [a 3-inch outside diameter split spoon is sometimes used when a large volume of soil is required. Diameters of the split spoons will be determined prior to sampling and specified in the site-specific QAPP]. The number of blows required to drive the split-spoon sampler provides an indication of the compaction/density of the soils being sampled. The split spoon is attached to the end of the drill rods, and the 0-foot to 2-foot interval split spoon is driven to the desired depth. The number of blows required to advance the split spoon each 6 inches for the 2-foot interval is recorded in the site log book or on field data sheets by WESTON. Upon reaching the desired sampling depth, the split spoon is slowly and carefully extracted from the boring.

Once the split spoon is removed from the drill rods, the split spoon will be placed on plastic sheeting in a horizontal position and opened by unscrewing the bit and head and splitting the barrel. A photoionization detector (PID) or flame ionization detector (FID) will be used to screen the sample as soon as the split spoon is opened. Sampling intervals will either be predetermined or decided in the field based on elevated field screening levels on the PID or FID, or based on visual observations.

If samples will be collected for VOC analysis, VOC samples will be immediately collected using a dedicated sampling spatula and placed directly into the appropriate size, prelabelled glass sample container. The samples will then be preserved by placing the sample container in a cooler with ice.

The length of the recovered core will be recorded in the site log book or on field data sheets by WESTON. WESTON will describe the soil in the split spoons using either the Burmeister Soil Classification or the Unified Soil Classification System. If hydrocarbon (e.g., gasoline) contamination is suspected, then headspace analysis will be performed as outlined in SOP, entitled *Standard Operating Procedures For Jar Headspace Screening*.

After collecting VOC samples and conducting headspace screening, the sample material is placed into a stainless steel bowl where it is homogenized using a stainless steel (or disposable) scoop. Any extraneous material not considered to be relevant for analysis is removed from the sample(s) during homogenization. The sample is then placed into the appropriate size, prelabelled sample containers for each analysis (e.g. SVOCs, pest/PCBs, metals, cyanide, asbestos, etc.) to be performed. The container cap(s) will then be secured, and the samples will be preserved by immediately placing the containers in a cooler on ice.

The driller will then advance the borehole to a depth of 5 feet using the drilling method as specified in the RFP. The drill rods will be withdrawn, and a clean (decontaminated) split spoon will be attached and lowered to the bottom of the borehole until its rests on top of the undisturbed soil. In order to obtain representative soil samples, the bottom of the borehole must be clean and the soil to be sampled must be undisturbed. The split spoon will be driven to the desired depth (5 - 7 feet), and the number of blows required to advanced the split spoon each 6 inches for the 2-foot interval will be recorded in the site log book or on field data sheets by WESTON. The split spoon will be slowly and carefully extracted from the boring. WESTON will measure the length of the recovered core, describe the soil in the split spoons, and collect soil for headspace screening.

Drilling will continue until the desired total depth of the boring is reached. A monitoring well will be constructed in the borehole or the borehole will be properly plugged according to state regulations or guidance. WESTON will document monitoring well construction details and/or plugging processes in the site log book or on field data sheets. The driller will decontaminate downhole drilling equipment between sample locations and prior to demobilzing from the site.

If a split sample is desired, a cleaned, stainless steel knife should be used to divide the tube contents in half, longitudinally. This sampler is typically available in diameters of 2 and 3½ inches. However, in order to obtain the required sample volume, use of a larger barrel may be required.

9.3.3 Geoprobe Soil Sample Collection Procedures

Subsurface soil samples may be collected using the geoprobe systems soil probing machine. This is a truck-mounted, piston-driven device which can be used to collect split-spoon samples, install microwells, collect groundwater samples, and conduct soil gas surveys. WESTON has prepared a separate SOP, entitled *Standard Operating Procedures For Sample Collection Procedures using the Geoprobe Systems Soil Probing Machine,* detailing this procedure. This SOP should be reviewed prior to collecting any samples with this method.

9.3.4 Test Pit/Trench Excavation Sample Collection Procedures

WESTON may collect subsurface soil samples during test pitting activities. Test pitting activities are typically conducted at sites where it is suspected that buried metal drums, tanks, and/or containers suspected of containing hazardous materials may be present, following geophysical surveys (terrain conductivity and magnetometer).

Qualified excavation subcontractors are either procured by WESTON via an RFP or by EPA's Emergency Rapid Response Services (ERRS) contractor to perform this service. When these services are procured by WESTON, the details of the Scope of Work for the site are divided into technical, administrative, health and safety, and general requirements.

Prior to any excavation with a backhoe, it is important to ensure that all sampling locations are clear of utility lines and poles (subsurface as well as above surface). During excavation activities, decontamination and containment materials will be supplied by the excavation subcontractor. Excavation activities will be organized to minimize contamination of equipment. It shall be the responsibility of the excavation subcontractor to decontaminate all equipment prior to use at the site as part of the mobilization activities. The excavation subcontractor will be responsible for decontaminating equipment, tracks or tires, and bucket, after each test pit and upon leaving an exclusion (i.e., potentially contaminated) zone. A vehicle decontamination area will be established by the excavation subcontractor, and the subcontractor will be required to follow WESTON's instructions for the proper decontamination of vehicles and equipment. Decontamination water will be collected in drums, provided by the excavation subcontractor, at the vehicle and equipment decontamination area for subsequent disposal.

Decontamination of the backhoe or excavator between test pits will consist of removing loose soil from the tracks or tires and bucket, and rinsing by using a steam and/or pressure washer equipped with an intermittent cleaning material siphon. Non-phosphate detergent solution will be used as a primary cleaning agent, and clean rinse water will follow. All extracted materials will be decontaminated by the subcontractor prior to disposal with the steam and/or pressure washer. The subcontractor will decontaminate equipment between test pit locations and prior to demobilzing from the site.

Test pitting affords the opportunity for the detailed examination of soil characteristics (stratification, texture, color, etc.) and to identify potential subsurface soil sample locations. Once sample locations are determined, WESTON will direct the excavation subcontractor to obtain a soil sample using the bucket of the excavator. WESTON will then collect soil samples from an area near the middle of the bucket. If samples will be collected for VOC analysis, VOC samples will be immediately collected using a dedicated sampling spatula and placed directly into the appropriate size, prelabelled glass sample container. The samples will then be preserved by placing the sample container in a cooler with ice.

After collecting VOC samples and screening for VOCs, the sample material will be placed into a stainless steel bowl where it is homogenized using a stainless steel (or disposable) scoop. Any extraneous material not considered to be relevant for analysis will be removed from the sample(s) during homogenization. The sample will then be placed into the appropriate size, prelabelled sample containers (preferably wide-mouthed) for each analysis (e.g. SVOCs, pest/PCBs, metals, cyanide, asbestos, etc.) to be performed. The container cap(s) will then be secured, and the samples will be preserved by immediately placing the containers in a cooler on ice.

10.0 Handling and Preservation

Trip blanks are used to assess the degree of contamination introduced into samples during sample handling, shipment, and analysis. Contamination may be introduced from the sample bottle, the preservatives used, cross-contamination (in the case of VOCs), or from shipping and handling, both in the field and in the laboratory. Samples are shipped to analytical laboratories expeditiously to ensure that holding times are not exceeded. Chemicals used during the decontamination process, including nitric acid, hexane, methanol, and isopropanol.

11.0 Sample Preparation and Analysis

This section is not applicable to this SOP.

12.0 Troubleshooting

All field screening instrumentation must be operated in accordance with operating instructions as supplied by the manufacturer, unless otherwise specified in the work plan. Equipment checkout and calibration activities must occur prior to sampling/operation, and they must be documented.

13.0 Data Acquisition, Calculations, and Data Reduction

13.1 Computer Hardware and Software

Surface soil sample locations and boring locations may be located using a Trimble Pro XRS or GeoExplorer Global Positioning System (GPS) receiver. Prior to conducting field work, Trimble Pathfinder Office 2.51 (Pathfinder software) may be used to generate a data dictionary to be used during collection of sample locations. The data dictionary is then transferred from the computer to the GPS datalogger. Upon returning from the field, GPS data are downloaded from the GPS datalogger to a computer using the Pathfinder software. GPS data undergo differential correction, with base station data obtained from a variety of community base stations depending upon geographic location to improve location accuracy. Pathfinder is used to export GPS data in a variety of formats [i.e. ArcView shapefile, ARC/INFO, dBASE, and AutoCAD export (DXF) files]. Typically, GPS data are exported into dBASE files, and then manipulated with Microsoft Excel 2000 software. Data are then manipulated where they can be utilized in site diagrams to display sample locations.

13.2 Data Management and Records Management

Field observations made during the sampling event will be recorded in a site log book and/or field data sheets, including description of sampling locations and any deviations from the Sampling and Quality Assurance Plan (SQAP) or Task Work Plan. Chain-of-custody will be maintained until samples are relinquished to a courier or to the laboratories assigned to perform the analyses. Photographs will be taken to document site conditions. The location and direction from which photographs are taken will be noted in the field log book, in accordance with the scope of work. Soil borings will be logged by the WESTON on-site geologist, and boring logs will be prepared following site activities. Reports, site file memoranda, figures, tables, boring logs, etc. will be saved in site-specific Technical Direction Document (TDD) directories.

14.0 Quality Control and Quality Assurance Section

This section describes QA/QC pertinent to surface and subsurface soil samples, and the types and uses of the QA/QC samples that are collected in the field. QA/QC samples are analyzed to provide information on the variability and usability of environmental sample results. They assist in identifying the origin of analytical discrepancies to help determine how the analytical results should be used. They are used mostly to validate analytical results.

A data quality review of the laboratory sample analyses will be conducted by U.S. EPA.

Field duplicates (replicates), MS/MSD, trip blanks, rinsate (equipment) blanks, and temperature blanks are discussed below. QA/QC results may suggest the need for modifying sample collection, preparation, handling, or analytical procedures if the resultant data do not meet quality assurance objectives.

14.1 Field Duplicates

Field duplicates are used to assess the degree of sample homogeneity, and the reproducibility of the sample collection procedure and the laboratory analysis. Field duplicates are typically collected with surface soil and subsurface soil samples which are submitted for field screening analysis or for site assessment scoring activities. One field duplicate is typically collected for each matrix type and sample parameter for every 20 stations. The field duplicate is assigned an individual sample number.

14.2 Laboratory Matrix Spike and Matrix Spike Duplicate

MS and MSD samples are used to monitor laboratory performance. MS/MSD samples are spiked in the laboratory with a known concentration of a target analyte(s) to verify percent recoveries. It may be necessary to provide extra volume of a sample to the laboratory for spiking analyses. Extra volume for MS/MSD or MS/Duplicate (Dupl) analyses is collected for every 20 samples of each matrix for each requested analytical parameter.

For surface soil and subsurface soil samples, extra volume is collected, homogenized thoroughly, and divided by alternately scooping the homogenized sample into two separate bottles. The exception occurs when collecting for VOC analysis, where extra VOC samples are collected immediately. The MS/MSD samples are assigned the same sample number.

14.3 Trip Blanks

Trip blanks are used to assess the degree of contamination introduced into samples during sample handling, shipment, and analysis. Contamination may be introduced from the sample bottle, the preservatives used, cross-contamination (in the case of VOCs), or from shipping and handling, both in the field and in the laboratory. Trip blanks are typically collected for VOC analysis. Trip blanks (organic-free water) will be collected prior to the sampling event. Each bottle of the trip blank sample will be preserved with one drop of 1:1 HCl per 20 ml of sample to achieve a pH < 2. Trip blanks are handled, transported, and analyzed in the same manner as the other samples collected for that analysis that day. One set of trip blanks is collected for VOC analysis for each cooler in which VOC samples are shipped.

14.4 Rinsate (Equipment) Blanks

Dedicated or decontaminated sampling equipment will be used at each surface and/or subsurface sample location to minimize cross-contamination. Surface and subbsurface sampling equipment must be decontaminated prior to the start of sampling activities as well as between sample locations, unless the sampling activity is dedicated to one sample location. Rinsate blanks are used to assess contamination (typically, cross-contamination) brought about by improper decontamination procedures between sampling stations. Rinsate blanks are not required for dedicated, disposable sampling implements. Examples of equipment requiring decontamination and rinsate blanks include augers, shovels, split spoons, and stainless steel scoops and mixing bowls.

Rinsate blanks are obtained by running analyte-free water over decontaminated sampling equipment to test for residual contamination. The water is collected into the appropriate sample containers which are handled (e.g., preserved), shipped, and analyzed identical to the samples collected that day. Where non-dedicated sampling equipment is used, rinsate blanks must be collected at the rate of one per day per 20 stations for each type of sampling equipment used.

14.5 Temperature Blanks

Temperature blanks provide information of the preservation (temperature) of the samples during shipment to the laboratories. Temperature blanks are obtained by pouring tap water into a 40-ml glass vial and placing one temperature blank per cooler of samples.

15.0 Reference Section

Roy F. Weston, Inc. December 1999. *Manual of Procedures for Shipping and Transporting Dangerous Goods.*

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U.S. Environmental Protection Agency. 1998. *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846.* 3rd Edition, Revision 5.

U.S. Environmental Protection Agency. 1999. *US EPA Contract Laboratory Program Statement Of Work For Organics Analysis, Multi-Media, Multi-Concentration.* Document Number OLM04.2.

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STANDARD OPERATING PROCEDURE FOR GROUNDWATER AND DRINKING WATER SAMPLING

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13 April 2001

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1.0 Scope and Applicability

The purpose of this Standard Operating Procedure (SOP) is to describe the procedures for Roy F. Weston, Inc. (WESTON®) personnel in collecting representative groundwater and drinking water samples. This SOP does not discuss the low stress (low-flow) method for collecting groundwater samples. A separate SOP, entitled *Standard Operating Procedure For Low-Flow Groundwater Sampling*, is included. This SOP should be reviewed prior to collecting groundwater samples using the low-flow method. Purposes for the collection and analysis of groundwater and drinking water samples by WESTON personnel will be detailed in site-specific Sampling and Quality Assurance Plans (SQAPs) and may include determining whether concentrations of hazardous substances in groundwater exceed established action levels, confirming or identifying hazardous substances that may have impacted the environment, determining if contaminants are migrating off site, or if the concentrations of hazardous substances may present a risk to public health, welfare, or the environment.

2.0 Summary of Method

Groundwater samples may be collected using a variety of methods and equipment. The methods and equipment used are generally dependent on the depth of the water in the well and the diameter of the well. Prior to sampling a monitoring well, the well must be purged. This may be done using different types of equipment, including bailers, submersible pumps, and inertia pump. At a minimum, three well volumes should be purged, if possible. Equipment must be decontaminated prior to use and between wells. Once purging is completed and the correct laboratory-cleaned sample containers have been prepared, sampling may proceed. Sampling may be conducted with any of the above equipment, and need not be the same as the device used for purging. Care should be taken when choosing the sampling device as some will affect the integrity of the sample. Sampling equipment must also be decontaminated prior to use and between monitoring wells. Sampling should occur in a progression from the least to most contaminated well, if this information is known. Drinking water samples will be collected from either a tap or spigot which is located prior to any filtration or aeration devices which may be present in the water supply system. The tap or spigot will be opened and the system allowed to flush until the water temperature, specific conductance, and pH have stabilized (approximately 5 to 10 minutes). The water flow will then be adjusted to approximately 500 milliliters (ml)/minute prior to sample collection.

3.0 Acronym List

AC	-	Alternating Current
cc	-	Cubic centimeters
CLP	-	Contract Laboratory Program
COC	-	Chain of Custody
DAS	-	Delivery of Analytical Services
DC	-	Direct Current
DOT	-	Department of Transportation
EPA	-	U.S. Environmental Protection Agency

FID	-	Flame Ionization Detector
ft^3	-	cubic feet
gal	-	gallons
GPS	-	Global Positioning System
HASP	-	Health and Safety Plan
HCl	-	Hydrochloric Acid
HNO_3	-	Nitric Acid
HPLC	-	High Performance Liquid Chromatography
IATA	-	International Air Transport Association
mg	-	milligrams
ml	-	Milliliters
MS/MSD	-	Matrix Spike/Matrix Spike Duplicate
NaOH	-	Sodium Hydroxide
Pest	-	Pesticides
pest/PCB	-	Pesticide/Polychlorinated Biphenyl
OSHA	-	Occupational Safety and Health Administration
PE	-	Performance Evaluation
PID	-	Photoionization Detector
PPE	-	Personal Protective Equipment
ppm	-	Parts per million
psi	-	Pounds per Square Inch
PRP	-	Potentially Responsible Party
PVC	-	Polyvinyl Chloride
QAPP	-	Quality Assurance Project Plan
QA/QC	-	Quality Assurance/Quality Control
RFP	-	Request for Proposal
SDG	-	Sample Delivery Group
SOP	-	Standard Operating Procedure
SQAP	-	Sampling and Quality Assurance Plan
START	-	Superfund Technical Assessment and Response Team
SVOC	-	Semivolatile Organic Compound
TDD	-	Technical Direction Document
TWP	-	Task Work Plan
µm	-	micrometers
VOC	-	Volatile Organic Compound
WESTON	-	Roy F. Weston, Inc.

4.0 Health and Safety Warnings

WESTON personnel performing work on hazardous waste sites will follow Occupational Safety and Health Administration (OSHA), U.S. Environmental Protection Agency (EPA), and WESTON specific health and safety procedures and protocols. WESTON personnel conducting on-site and off-site groundwater and drinking water sampling activities will also be performing tasks in accordance with EPA-approved SQAPs.

In order to ensure the safety of personnel during sampling activities, the buddy system, periodic air monitoring, and caution will be used throughout field activities. To minimize risks due to chemical exposure, dermal and respiratory protection may be required if air monitoring equipment indicates that the environment is unsafe. Field activities will follow the site health and safety plan (HASP), which further addresses the safety considerations of the property. Hazards identified in or around the site may include physical hazards (slips, trips, and falls), lifting injuries associated with pump and bailer retrieval, moving equipment, use of pocket knives for cutting tubing, heat/cold stress as a result of exposure to extreme temperatures, and potential hazards that may exist in association with the use of electrical equipment.

Groundwater and drinking water samples collected at the site or at off-site private residences will be shipped to predesignated Contract Laboratory Program (CLP) and/or Delivery of Analytical Services (DAS) laboratories according to either Department of Transportation (DOT) Hazardous Materials Regulations or International Air Transport Association (IATA) Dangerous Goods Regulations, or hand-delivered to the predesignated laboratories. Samples will be transported in a manner that will maintain their integrity, as well as protect against detrimental effects from sample breakage or leakage. The Roy F. Weston, Inc. *Manual of Procedures for Shipping and Transporting Dangerous Goods* will be followed whenever samples are shipped.

Decontamination wastes will be collected and secured on site. Separate containers will be used for the aqueous wastes and for flammable, non-chlorinated solvents (methanol and hexane) wastes. Proper personal protection will be worn during decontamination procedures and will include gloves, eye protection and splash-resistant protective clothing. Off-site disposal of decontamination wastes, purge water, and contaminated personal protective equipment (PPE) will be conducted for disposal of investigation-derived wastes. Non-contaminated wastes will be tightly sealed, double-bagged, and disposed of appropriately.

5.0 Interferences

The primary goal of groundwater and drinking water sampling is to obtain representative samples. Laboratory analysis can be compromised by field personnel in two primary ways: cross-contamination of samples or collecting unrepresentative samples. Other potential problems in groundwater sampling may result from improper purging techniques or the composition of the materials used to purge and collect groundwater samples.

Cross-contamination problems can be eliminated or minimized through the use of dedicated sampling equipment. If this is not possible or practical, then decontamination of sampling equipment is necessary. Improper sample collection can involve the use of contaminated equipment resulting in variable, non-representative results. Following strict sampling procedures and utilizing trained field personnel will also eliminate or minimize cross-contamination problems.
Little or no vertical mixing of the water takes place in a non-pumping well, resulting in stratification of the water column. The well water in the screened section of the well will mix with the groundwater due to normal flow patterns, but the well water above the screened section will remain

isolated and become stagnant, and may lack the volatile organic compound (VOCs) that are representative of the groundwater. The stagnant water may contain foreign material inadvertently or deliberately introduced from the surface, resulting in a non-representative groundwater sample.

To eliminate or minimize against collecting a non-representative groundwater sample, the monitoring wells should be pumped or bailed prior to sampling. Purge water should be containerized on site or handled as specified in the site-specific project plan, HASP, and Request for Proposal (RFP). Evacuation of preferably three to five volumes in the well casing is recommended in order to collect a representative groundwater sample.

For wells that can be pumped or bailed dry, the wells should be evacuated and allowed to recover prior to sample collection. If the recovery rate is fairly rapid and the schedule allows, evacuation of more than one volume of water is preferred. If recovery is slow, the well may be sampled upon recovery after one evacuation.

Non-representative samples can also result from excessive pre-pumping of the monitoring well. Stratification of the leachate concentration if present in the aquifer may occur, or heavier-than-water compounds may sink to the lower portions of the aquifer. Excessive pumping can dilute or increase the contaminant concentrations from what is representative of the sampling point of interest.

Samplers and evacuation equipment (pumps, bailers, tubing, etc.) should be limited to those made with stainless steel, Teflon, and glass at sites where concentrations are expected to be at or near the detection limit. The tendency of organics to leach into and out of many materials make the selection of materials critical for trace analyses.

6.0 Personnel Qualifications

Training of WESTON personnel will be provided to ensure that technical, operational, and quality requirements are understood. WESTON personnel are trained in-house and in-field to conduct groundwater and drinking water sampling activities. Training includes reviewing this SOP and other applicable SOPs and/or guidance documents, health and safety training, "hands-on" experience conducting sampling activities with more experienced personnel, and training with instrument calibrations.

7.0 Apparatus and Materials

Equipment/materials for collecting groundwater and drinking water sampling includes, but is not limited to, the following:

General:

- Site-specific QAPPs.
- SOP for Groundwater and Drinking Water Sampling.
- Safety equipment and PPE specified in the site HASP.
- Field map of site.
- Logbook.
- Field data sheets (e.g. boring logs, soil description sheets, etc.).
- Graph paper.
- Calculator.
- Sample containers (pre-labeled).
- Water level indicator.
- Appropriate keys for well cap locks.
- Interface probe (oil/water).
- Sharp knife (locking blade).
- Tool box (to include at least: socket wrench, screwdrivers, pliers, hacksaw, hammer, flashlight, adjustable wrench).
- Bolt cutters.
- Photoionization detector (PID) or flame ionization detector (FID).
- Camera and film.
- Decontamination fluids and equipment (pump sprayers, brushes, etc.).

- Plastic sheeting (Visqueen).
- Plastic tubs and 5-gallon pails.
- Sealable plastic bags.
- Labels.
- Chain-of-custody (COC) forms and seals.
- Aluminum foil.
- Preservatives.
- High performance liquid chromatography (HPLC) water.
- pH paper.
- Coolers and ice.
- Vermiculite and packing materials.
- Strapping tape.

Bailers:

- Clean, decontaminated or dedicated bailer(s) of appropriate size and construction material.
- Nylon line, enough to dedicate to each well.
- Teflon-coated bailer wire.
- Sharp knife.
- Aluminum foil (to wrap clean bailers).
- 5-gallon buckets.

Submersible Pumps:

- Pump(s).

- Generator (110-, 120-, or 240-volt) or 12-volt battery if inaccessible to field vehicle.
- 1-inch black polyvinyl chloride (PVC) coil pipe - enough to dedicate to each well.
- Hose clamps.
- Safety cable.
- Tool box (with pipe wrenches, wire strippers, electrical tape, heat shrink, hose connectors, and Teflon tape).
- Winch or pulley.
- Gasoline for generator.
- Flow meter with gate valve.
- 1-inch nipples and various plumbing (i.e., pipe connectors).

Suction Pump:

- Pump.
- Power supply (power pack, battery, generator).
- Gasoline -- if required.
- Flexible tubing (tygon).
- Tubing (polypropylene).
- Plumbing fittings.
- Flow meter with gate valve.

Inertia Pump:

- Pump assembly (WaTerra™ pump, piston pump).
- 5-gallon bucket.

7.1 Reagents

Reagents used for the preservation of groundwater and drinking water samples include hydrochloric acid (HCl), nitric acid (HNO_3), sodium hydroxide (NaOH), sodium sulfite, and ascorbic acid. HCl, HNO_3, and NaOH are used to preserve groundwater and drinking water samples collected in the field for VOC, metals, and cyanide analyses, respectively. Sodium sulfite and ascorbic acid are used as reducing agents for drinking water samples testing positive for free chlorine before sample preservation. Ascorbic acid is used as a reducing agent for samples collected for VOC and cyanide analyses, and sodium sulfite is used as reducing agent for samples collected for semivolatile organic compound (SVOC) analysis. Reagents used for decontamination of sampling equipment are discussed in *Section 4.0, Health and Safety Warnings.*

8.0 Method Calibration

This section is not applicable to this SOP.

9.0 Sample Collection

9.1 Preparation

Following EPA approval of the site-specific SQAP, and prior to conducting sampling activities, a pre-sampling meeting will be held by WESTON personnel to discuss the proposed sampling strategy and site health and safety issues. During the pre-sampling meeting, the Site Leader will discuss the site history, contaminants of concern, sampling methodology, individual responsibilities, sample shipment or delivery, health and safety issues, and lines of communication anticipated during the sampling event. Generally, newly installed monitoring wells are allowed to equilibrate a minimum of 2 weeks prior to sampling.

Prior to mobilizing to the site to conduct sampling activities, the Site Leader will fill out an equipment/supply list and transmit the list to the WESTON Equipment Stores technician one week prior to the sampling event. Necessary sampling equipment, sample containers, PPE, and vehicles are therefore reserved. CLP and/or DAS laboratories are procured or secured one week prior to the sampling event also.

Once at the site, groundwater sampling will begin at the least-contaminated well, if known. Plastic sheeting will be placed around the well to minimize likelihood of contamination of equipment from soil adjacent to the well. The well cap and, if necessary, the well casing cap will be removed. The headspace of the well will then be screened for VOCs with the appropriate air monitoring instrument (FID or PID) to determine the presence of VOCs. The water level measuring device will be lowered into the well until the water surface is encountered, and the distance from the water surface to a reference measuring point on the well casing will be measured. This information will be recorded in the site log book or field data sheets. If there is no reference point, WESTON will note that water level measurement is from top of steel casing, top of PVC riser pipe, from ground surface, or some other position on the well head. The total depth of well (this will be done at least twice to confirm measurement) will be measured and recorded in the site log book or field data sheets. The volume of water in the well and the volume to be purged will then be calculated. The well volume is calculated from measurements between the top of the water table to the bottom of the well. For a 2-inch diameter well, the height of the water column in the well is multiplied by 0.1632 to determine the volume in gallons in the well. See *Section 13.0, Data Acquisition, Calculations, and Data Reduction* for calculating well volumes for other size diameter wells. Once the well volume has been calculated, the well will be purged by lowering the appropriate purging and sampling equipment into the well and purging water from the well. The purge water will be collected in appropriate containers for disposal. Disposal of purge water and contaminated materials is discussed in *Section 4.0, Health and Safety Warnings*.

9.2 Evacuation of Static Water (Purging)

The amount of flushing a well receives prior to sample collection depends on the intent of the sampling program as well as the hydrogeologic conditions. Programs where determination of overall quality of water resources is involved may require long pumping periods to obtain a sample that is representative of a large volume of that aquifer. The pumped volume can be determined prior to sampling so that the sample is a composite of known volume of the aquifer; or the well can be pumped until the stabilization of the parameters such as temperature, electrical conductance, or pH has occurred.

However, sampling for defining a contaminant plume requires a representative sample of a small volume of the aquifer. These circumstances require that the well be pumped enough to remove the stagnant water but not enough to induce flow from other areas. Generally, three well volumes are considered effective; or calculations can be made to determine, on the basis of the aquifer parameters and well dimensions, the appropriate volume to remove prior to sampling. During purging, water level measurements may be taken regularly at 15- to 30-second intervals. These data may be used to compute aquifer transmissivity and other hydraulic characteristics.

WESTON most commonly uses the following well evacuation devices.

9.2.1 Bailers

Bailers are the simplest purging devices used. They generally consist of a rigid length of tube, usually with a ball check-valve at the bottom. A line is used to lower the bailer into the well and retrieve a volume of water. The three most common types of bailer are PVC, Teflon, and stainless steel.

This manual method of purging is best suited to shallow or narrow diameter wells. For deeper, larger diameter wells which require evacuation of large volumes of water, other mechanical devices may be more appropriate.

Bailing equipment includes a clean decontaminated bailer, Teflon or nylon line, a sharp knife, and plastic sheeting. The following procedures are used to purge water using bailers.

- The volume of water to be purged is calculated as described in Section 13.0.
- Plastic sheeting is placed around the well to prevent contamination of the bailer line with foreign materials.
- A line is attached to the bailer, and the bailer is lowered into the well until it is completely submerged.
- The bailer is slowly pulled out of the well, ensuring that the line either falls onto a clean area of plastic sheeting or never touches the ground.
- The bailer is emptied into a 5-gallon pail until the required volume of water is purged.
- The contents of the 5-gallon pail are then poured into a 55-gallon drum and secured until proper disposal can occur.

9.2.2 Submersible Pumps

Submersible pumps are generally constructed of plastic, rubber, and metal parts which may affect the analysis of samples for certain trace organics and inorganics. As a consequence, submersible pumps may not be appropriate for investigations requiring analyses of samples for trace contaminants. However, they are still useful for pre-sample purging. However, the pump must have a check valve to prevent water in the pump and the pipe from rushing back into the well.

Submersible pumps generally use one of two types of power supplies, either electric or compressed gas. Electric pumps can be powered by a 12-volt direct current (DC) rechargeable battery, or a 110- or 220-volt alternating current (AC) power supply. Those units powered by a compressed gas normally use a small electric compressor which also needs 12-volt DC or 110-volt AC power. They may also utilize compressed gas from bottles. Pumps differ according to the depth and diameter of the monitoring wells. The following procedures are used to purge water using submersible pumps.

- The volume of water to be purged is calculated as described in Section 13.0.
- Plastic sheeting is placed around the well to prevent contamination of pumps, hoses or lines with foreign materials.

- The pump, hoses and safety cable are assembled, and the pump is lowered into the well. Make sure the pump is deep enough so that purging does not evacuate all the water (running the pump without water may cause damage).

- The flow meter is attached to the outlet hose to measure the volume of water purged.

- The power supply is attached, and the well is purged until the specified volume of water has been evacuated (or until field parameters, such as temperature, pH, conductivity, etc. have stabilized). The pump should not be allowed to run dry. If the pumping rate exceeds the well recharge rate, the pump is lowered farther into the well, and pumping is continued.

- The purge waters are collected and properly disposed of as specified in the site-specific project plan.

9.2.3 Suction Pumps

There are many different types of suction pumps. They include: centrifugal, peristaltic, and diaphragm. Suction pumps can be used for well evacuation and sampling at a low pumping rate. WESTON generally uses peristaltic pumps. The peristaltic pump is a low-volume pump that uses rollers to squeeze a flexible (tygon) tubing, thereby creating suction. Use of a peristaltic pump is limited to shallow depths (< 25 feet). This tubing can be dedicated to a well to prevent cross-contamination. In addition, peristaltic pumps, require a power source. The following procedures are used to purge water using suction pumps.

- The volume of water to be purged is calculated as described in Section 13.0.

- Plastic sheeting is placed around the well to prevent contamination of pumps, hoses or lines with foreign materials.

- The pump, tubing, and power source, if necessary, are assembled.

- The tubing is lowered into the well.

- The flow meter is attached to the outlet hose to measure the volume of water purged, or the volume of water can be measured using a graduated cylinder.

- The power supply is attached, and the well is purged until the specified volume of water has been evacuated (or until field parameters, such as temperature, pH, conductivity, etc. have stabilized).

- If the pumping rate exceeds the well recharge rate, the pumping rate is decreased, and pumping is continued.

- The purge waters are collected and properly disposed of as specified in the site-specific project plan.

9.2.4 Inertia Pumps

Inertia pumps, such as the WaTerra pump and piston pump, are manually operated. They are appropriate to use when wells are too deep to bail by hand. These pumps are made of plastic and may be either decontaminated or discarded after use. The following procedures are used to purge water using inertia pumps.

- The volume of water to be purged is calculated as described in Section 13.0.

- Plastic sheeting is placed around the well to prevent contamination of pumps, hoses or lines with foreign materials.

- The pump is assembled and lowered to the appropriate depth in the well.

- Pumping is begun manually, and the water is discharged into a 5-gallon bucket (or graduated cylinder). Purging is continued until the specified volume of water has been evacuated (or until field parameters such as temperature, pH, conductivity, etc. have stabilized).

- The purge waters are collected and properly disposed of as specified in the site-specific project plan.

9.3 Groundwater Sample Collection

Prior to conducting any on-site activities, WESTON personnel will review and sign the site-specific HASP. WESTON will establish a command post upwind of suspected source areas, if possible. WESTON will perform calibration checks of air monitoring instruments and document background ambient air levels. The samplers will decontaminate the sampling equipment. Decontamination will be conducted in accordance with the HASP and/or applicable SOPs. Decontamination generally consists of an alconox and water wash followed by a distilled water rinse, followed by an isopropanol rinse (following collection of visibly or otherwise obviously contaminated samples), followed by a de-ionized water final rinse, and air drying. Decontamination fluids and PPE generated during sampling activities will be containerized and disposed appropriately based on the results of laboratory analyses of samples collected.

The number of groundwater samples and the sample locations are described in the approved site-specific QAPP. Under the Removal Program, groundwater samples are generally collected to determine if hazardous substances have migrated from on-site sources to the groundwater, or have migrated off site and impacted private and public wells. Under the Site Assessment Program, groundwater samples are generally collected to evaluate the groundwater pathway and determine if hazardous substances attributable to on-site sources have migrated off site and have impacted private wells and public wells. Groundwater samples are also used in the Site Assessment Program to identify Level I and/or Level II targets under the Hazard Ranking System.

The following section discusses collecting groundwater samples for typical parameters. Sample withdrawal methods require the use of bailers and pumps. Ideally, purging and sample withdrawal equipment should be completely inert, economical to use, easily cleaned, sterilized, reusable, able to operate at remote sites in the absence of power resources, and capable of delivering variable pumping rates for sample collection.

There are several factors to take into consideration when choosing a sampling device. Care should be taken when reviewing the advantages or disadvantages of any one device. It may be appropriate to use a different device to sample than that which was used to purge, e.g. the use of a submersible pump to purge and a bailer to sample.

Groundwater samples may also be collected using the geoprobe systems soil probing machine. This is a truck-mounted, piston-driven device which can be used to collect groundwater samples and split-spoon soil samples; install microwells; and conduct soil gas surveys. A separate SOP, entitled *Sampling of Soil, Soil Gas, and Groundwater Using a Direct Push Sampling System*, has been prepared and should be reviewed prior to collecting any groundwater samples with this method.

Bailer

The positive-displacement volatile sampling bailer is perhaps the most appropriate for collection of water samples for VOC analysis. Other bailer types (messenger, bottom fill, etc.) are less desirable, but may be mandated by cost and site conditions. Generally, bailers can provide an acceptable sample, providing that sampling personnel use extra care in the collection process. The following procedures are followed when collecting groundwater samples using bailers.

The monitoring well will be surrounded with clean plastic sheeting. A line will be attached to the bailer (if a bailer was used for purging, the same bailer and line may be used for sampling) and the bailer will be lowered slowly and gently into the well, with care being taken not to shake the casing sides or splash the bailer into the water. The bailer will stop being lowered at a point adjacent to the screen; the bailer will be allowed to fill, and then the bailer will be slowly and gently retrieved from the well. Contact with the casing will be avoided, so as not to knock flakes of rust or other foreign materials into the bailer. The liquid will then be transferred into the appropriate, prelabelled sample container(s). When collecting samples for VOCs, special care will be taken to minimize turbulence and loss of volatiles when transferring well water from the bailer to the sample container(s). Reinsertion of the bailer into the well may be repeated until the necessary volume of sample is collected.

The cap will be removed from the sample container and placed on the plastic sheet or in a location where it will not become contaminated. The sampler will begin pouring slowly from the bailer. Groundwater samples will be collected in the following manner.

VOC Sampling - The proper collection of a sample for VOC analysis requires minimal disturbance of the sample to limit volatilization and therefore prevent loss of volatile compounds from the sample. VOC samples shall not be collected and/or preserved near a running motor or any type of exhaust system due to possible contamination by discharges, fumes or vapors. Each container will be preserved with one drop of 1:1 HCl per 20 ml of sample so that the pH is < 2. To collect a sample, open the container, set the cap in a clean place, and collect the sample. When collecting replicate samples, collect both samples at the same time. Fill the container to just overflowing until there is a convex meniscus on the top of the container. Check that the cap has not been contaminated (splashed) and carefully cap the container. Place the cap directly over the top and screw down firmly. Do not overtighten and break the cap. The sealed container will be inverted, tapped gently on the side, and observed for 10 seconds for the presence of air bubbles. If an air bubble appears, the sample will be discarded and the collection procedure repeated. The sample containers will then be shaken vigorously to mix the preservative, placed in a resealable plastic bag, and placed into a cooler with ice. The holding time for VOC samples is 7 days. Samples should be shipped or delivered to the laboratory daily so as not to exceed the holding time. Ensure that the samples remain at 4°C, but do not allow them to freeze.

One trip blank sample (organic-free water) will be collected prior to the sampling event. Preparation of trip blanks is discussed in *Section 14.3, Trip Blanks*.

SVOC Sampling - Samples will be collected by pouring groundwater directly from the bailer into the appropriate size glass container. Cap the sample container tightly, and place pre-labeled sample container in a cooler with ice.

Pesticides(Pest)/PCBs Sampling - Samples will be collected by pouring groundwater directly from the bailer into the appropriate size glass container. Cap the sample container tightly, and place pre-labeled sample container in a cooler with ice.

Metals Sampling - Samples will be collected by pouring groundwater directly from the bailer into the appropriate size glass container and preserved with HNO_3 to a pH of < 2. Cap the sample container tightly, and place pre-labeled sample container in a cooler with ice.

Cyanide (Total and Amenable) Sampling - Samples will be collected by pouring groundwater directly from the bailer into the appropriate size glass container. Samples will be preserved with NaOH to a pH of > 12. Cap the sample container tightly, and place pre-labeled sample container in a cooler with ice.

Oil Identification Sampling - Sample will be collected by pouring groundwater directly from the bailer into the appropriate size glass container. Cap the sample container tightly, and place pre-labeled sample container in a cooler with ice. If an oil layer is present on top of the water surface, a representative amount of the oil should be collected with the sample. The procedure for collecting oil layer product is discussed below.

- Oil Product Layer Samples - Sampling procedures for the purpose of obtaining an oil layer floating on the top of the groundwater will not include purging procedures. As a result, the sample volume from each well will be limited to one bailer full of water and/or oil. Before the sample is collected, it is recommended that the profile of the well column be measured with a decontaminated oil/water interface probe to determine the depth and thickness of the oil/water layer.

  Once the well has been characterized with the interface probe, a dedicated teflon bailer will be slowly lowered into the well until it is immersed in the oil layer. Care will be taken not to mix the oil and water layers. The bailer is then allowed to fill with the liquid and is slowly retracted from the well. Once the bailer has been retracted, any water present below the oil layer in the bailer will be discharged by the sampler through the bottom valve of the bailer. The oil is then transferred into the appropriate, prelabelled sample container(s).

  Cap the sample container tightly and place pre-labeled sample container in a cooler with ice. Samples containers will be placed in separate resealable plastic bags after the sample is collected to avoid cross-contamination.

Once sampling of the well is complete, replace the well casing cap, and replace and lock the protective casing cap. Log all samples in the site logbook and on field data sheets, label all samples, record the times samples were collected, and complete necessary paperwork. Package and prepare the samples for shipment or transport to the appropriate analytical laboratories.

For samples that require filtering, such as samples which will be analyzed for dissolved metals, the filtering equipment must be decontaminated prior to use and between uses. Filters work by several methods. A barrel filter such as the "Geotech" filter works with a bicycle pump, which is used to build up positive pressure in the chamber containing the sample. The sample is then forced through the disposable filter paper [minimum size 0.45 micrometers (μm)] into a jar placed underneath. The barrel itself is filled manually from the bailer or directly via the hose of the sampling pump. The pressure must be maintained up to 30 pounds per square inch (psi) by periodic pumping. A vacuum type filter involves two chambers; the upper chamber contains the sample, and a filter (minimum size 0.45 μm) divides the chambers. Using a hand pump or a Gilian-type pump, air is withdrawn from the lower chamber, creating a vacuum and thus causing the sample to move through the filter into the lower chamber, where it is drained into a sample jar. Repeated pumping may be required to drain all the sample into the lower chamber. When pumps are used to sample groundwater, the sample may be filtered using a cartridge type filter attached to the end of the hose. The filtered sample can be pumped directly through the filter into the sample container. At least 1-L of sample should be pumped through the filter (and discarded) before filling the container.

If preservation of the sample is necessary, this should be done after filtering.

In cases where split samples are required, extra sampling containers will be prepared. Split samples are generally collected when requested by the potentially responsible party (PRP).

Submersible Pumps

The following procedures are followed when collecting groundwater samples using submersible pumps. Surround the monitoring well with clean plastic sheeting. Allow the monitoring well to recharge after purging, keeping the pump just above the screened section. Attach a gate valve to hose (if not already fitted), and reduce flow of water to a manageable sampling rate. Assemble the appropriate bottles, and transfer the groundwater sample into the appropriate, prelabelled sample containers. When collecting samples for VOCs, special care will be taken to minimize turbulence and loss of volatiles when transferring well water into the sample containers. The same procedures for collecting groundwater samples using bailers should be followed. Procedures for collecting groundwater samples for other parameters (SVOCs, pest/PCBs, metals, cyanide, pH, and oil identification) should also follow those described for bailers.

Upon completion, remove the pump and assembly and fully decontaminate prior to sampling the next well, and dedicate the tubing to the well. Replace the well casing cap, and replace and lock the protective casing cap. Log all samples in the site logbook and on field data sheets, label all samples, record the times samples were collected, and complete necessary paperwork. Package the samples and prepare the samples for shipment or transport to the appropriate analytical laboratories.

Suction Pumps

Suction pumps are generally used to sample small diameter wells (< 1 inch) where the top of the water table is shallow (< 25 feet). The following procedures are followed when collecting groundwater samples using suction pumps. Surround the monitoring well with clean plastic sheeting. Allow the monitoring well to recharge after purging, and lower the tubing into the well. Turn the pump on and adjust the flow rate to a manageable sampling rate. Assemble the appropriate bottles, and transfer the groundwater sample into the appropriate, prelabelled sample containers. When collecting samples for VOCs, special care will be taken to minimize turbulence and loss of volatiles when transferring well water into the sample containers. The same procedures for collecting groundwater samples using bailers should be followed. Procedures for collecting groundwater samples for other parameters (SVOCs, pest/PCBs, metals, cyanide, pH, and oil identification) should also follow those described for bailers.

Upon completion, remove the tubing from the well and dispose of properly. Replace the well casing cap, and replace and lock the protective casing cap. Log all samples in the site logbook and on field data sheets, label all samples, record the times samples were collected, and complete necessary paperwork. Package the samples and prepare the samples for shipment or transport to the appropriate analytical laboratories.

Inertia Pump

Inertia pumps may be used to collect samples. It is more common, however, to purge with these pumps and sample with a bailer. The following procedures are followed when collecting groundwater samples using inertia pumps. Surround the monitoring well with clean plastic sheeting. Allow the monitoring well to recharge after purging. Assemble the appropriate bottles and transfer the groundwater sample into the appropriate, prelabelled sample containers. Since these pumps are manually operated, the flow rate may be regulated by the sampler. The sample may be discharged from the pump outlet directly into the appropriate sample container. When collecting samples for VOCs, special care will be taken to minimize turbulence and loss of volatiles when transferring well water into the sample containers. The same procedures for collecting groundwater samples using bailers should be followed. Procedures for collecting groundwater samples for other parameters (SVOCs, pest/PCBs, metals, cyanide, pH, and oil identification) should also follow those described for bailers.

Upon completion, remove pump and decontaminate or discard, as appropriate. Replace the well casing cap, and replace and lock the protective casing cap. Log all samples in the site logbook and on field data sheets, label all samples, record the times samples were collected, and complete necessary paperwork. Package the samples and prepare the samples for shipment or transport to the appropriate analytical laboratories.

9.4 Drinking Water Sample Collection

The number and locations of drinking water samples to be collected will be described in the EPA-approved site-specific QAPPs. Under the Removal Program, drinking water samples are generally collected to determine if hazardous substances have migrated off site and impacted private drinking water wells. Under the Site Assessment Program, drinking water samples are generally collected to evaluate the groundwater pathway and determine if hazardous substances attributable to on-site sources have migrated off site and have impacted private wells and public wells. Drinking water samples are also used in the Site Assessment Program to identify Level I and/or Level II targets under the Hazard Ranking System.

Drinking water samples will be collected from either a tap or spigot which is located prior to any filtration or aeration devices which may be present in the water supply system. The tap or spigot will be opened and the system allowed to flush until stabilization of parameters such as temperature, electrical conductance, or pH has occurred (approximately 5 to 10 minutes). The water flow will then be adjusted to approximately 500 ml/minute prior to sample collection. Sample collection will involve the filling of the appropriate sample containers directly from the tap or spigot. The tap or spigot from which the samples were collected shall be recorded on the COC record. When the sample container is full, the cap will then be secured and the sample will be placed in a cooler with ice.

When conducting sampling of a drinking water supply where free (residual) chlorine may be present (chlorinated public drinking water), the water will be tested for free chlorine by using chlorine test strips according to the manufacturer's directions. When collecting samples for VOC, SVOC or cyanide analyses, samples that test positive for residual chlorine will require treatment with a reducing agent before sample preservation. Well water samples are not expected to contain free chlorine.

Sample Collection Procedures for Non-Chlorinated Drinking Water Samples:

VOC Sampling - The proper collection of a sample for VOC analysis requires minimal disturbance of the sample to limit volatilization and therefore prevent loss of volatile compounds from the sample. VOC samples shall not be collected and/or preserved near a running motor or any type of exhaust system due to possible contamination by discharges, fumes or vapors.

The pH of the drinking water sample will be adjusted to < 2 by carefully adding the appropriate number of 1:1 HCl drops. Generally, one drop of 1:1 HCl for each 20 ml of sample volume is adequate; however, some samples collected in the field have different buffering capacities and may require additional drops of HCl to achieve a pH of < 2. Alternately, the sample containers can be pre-preserved with HCl and the sample carefully filled to just overflowing to avoid washing out the preservative. To collect a sample, open the container, set the cap in a clean place, and collect the sample during the middle of the cycle. When collecting replicate samples, collect both samples at the same time. Fill the container to just overflowing until there is a convex meniscus on the top of the container. Check that the cap has not been contaminated (splashed), and carefully cap the container. Place the cap directly over the top and screw down firmly. Do not overtighten and break the cap. The sealed container will be inverted, tapped gently on the side, and observed for 10 seconds for the presence of air bubbles. If an air bubble appears, the sample will be discarded and the collection procedure repeated. The sample containers will then be shaken vigorously for 1 minute to mix the preservative, placed in a resealable plastic bag, and placed into a cooler with ice. The holding time for VOC samples is 7 days. Samples should be shipped or delivered to the laboratory daily so as not to exceed the holding time. Ensure that the samples remain at 4°C, but do not allow them to freeze.

One trip blank sample (organic-free water) will be collected prior to the sampling event. Preparation of trip blanks is discussed in *Section 14.3, Trip Blanks*.

<u>SVOC Sampling</u> - Samples will be collected directly from a tap or spigot (prior to any filtration or aeration devices) and into the appropriate size glass container. Cap the sample container tightly, and place pre-labeled sample container in a cooler with ice.

<u>Pesticides/PCBs Sampling</u> - Samples will be collected directly from a tap or spigot (prior to any filtration or aeration devices) and into the appropriate size glass container. Cap the sample container tightly, and place pre-labeled sample container in a cooler with ice.

<u>Metals Sampling</u> - Samples will be collected directly from a tap or spigot (prior to any filtration or aeration devices) and into the appropriate size glass or plastic containers and preserved with HNO_3 to a pH of < 2. Cap the sample container tightly, and place pre-labeled sample container in a cooler with ice.

<u>Cyanide (Total and Amenable) Sampling</u> - Samples will be collected directly from a tap or spigot (prior to any filtration or aeration devices) and into the appropriate size glass or plastic containers. Samples will be preserved with NaOH to a pH of > 12. Cap the sample container tightly, and place pre-labeled sample container in a cooler with ice.

<u>Sample Collection Procedures for Chlorinated Drinking Water Samples</u>:

<u>VOC Sampling</u> - The proper collection of a sample for VOC analysis requires minimal disturbance of the sample to limit volatilization and therefore prevent loss of volatile compounds from the sample. VOC samples shall not be collected and/or preserved near a running motor or any type of exhaust system due to possible contamination by discharges, fumes or vapors.

Drinking water samples will be collected in glass sample containers to which 25 milligrams (mg) (for 40-ml containers) or 75 mg (for 125-ml containers) of ascorbic acid has been added. Fill the container to just overflowing until there is a convex meniscus on the top of the container. Care will be taken to avoid flushing the ascorbic acid from the sample container. The pH of the sample will be adjusted to < 2 by carefully adding the appropriate number of 1:1 HCl drops. Generally, one drop of 1:1 HCl for each 20 ml of sample volume is adequate; however, some samples collected in the field have different buffering capacities and may require additional drops of HCl to achieve a pH of < 2. Check that the cap has not been contaminated (splashed) and carefully cap the container. Place the cap directly over the top and screw down firmly. Do not overtighten and break the cap. The sealed container will be inverted, tapped gently on the side, and observed for 10 seconds for the presence of air bubbles. If an air bubble appears, the sample will be discarded and the collection procedure repeated. The sample containers will then be shaken vigorously for 1 minute to mix the preservative, placed in a resealable plastic bag, and placed into a cooler with ice.

The holding time for VOC samples is 7 days. Samples should be shipped or delivered to the laboratory daily so as not to exceed the holding time. Ensure that the samples remain at 4°C, but do not allow them to freeze.

One trip blank sample (organic-free water) will be collected prior to the sampling event. Preparation of trip blanks is discussed in *Section 14.3, Trip Blanks*.

SVOC Sampling - Samples will be collected directly from a tap or spigot (prior to any filtration or aeration devices) and into the appropriate size glass container to which 40 to 50 mg of sodium sulfite has been added. Care will be taken to avoid flushing the sodium sulfite from the sample container. The samples will then be preserved with HCl to a pH < 2 and then placed in a cooler with ice.

Cyanide (Total and Amenable) Sampling - Samples will be collected directly from a tap or spigot (prior to any filtration or aeration devices) and into the appropriate glass or plastic containers to which 0.6 gm of ascorbic acid has been added. Care will be taken to avoid flushing the ascorbic acid from the sample container. The samples will then be preserved with NaOH to a pH of > 12 and placed in a cooler with ice.

10.0 Handling and Preservation

Trip blanks are used to assess the degree of contamination introduced into samples during sample handling, shipment, and analysis. Contamination may be introduced from the sample bottle, the preservatives used, cross-contamination (in the case of VOCs), or from shipping and handling, both in the field and in the laboratory. Samples are shipped to analytical laboratories expeditiously to ensure that holding times are not exceeded. Chemical preservatives used during groundwater and drinking water sampling activities include HCl, HNO_3, NaOH, sodium sulfite, and ascorbic acid. Other chemicals may be used during the decontamination process, including hexane and isopropanol.

11.0 Sample Preparation and Analysis

This section is not applicable to this SOP.

12.0 Troubleshooting

All field screening instrumentation and pumps must be operated in accordance with operating instructions as supplied by the manufacturer, unless otherwise specified in the site-specific QAPPs. Equipment checkout and calibration activities must occur prior to sampling/operation, and they must be documented.

13.0 Data Acquisition, Calculations, and Data Reduction

Calculations are necessary to determine the volume of water contained within the monitoring wells to ensure the correct volume of water is removed during purging operations. The volume of water contained within a well is calculated as follows.

$$\text{Well volume} = nr^2h\,(cf) \quad \text{[Equation 1]}$$

where:

- n = 3.14
- r = radius of monitoring well (feet)
- h = height of the water column (feet) [This may be determined by subtracting the depth to the top of the water from the total depth of the well as measured from the same reference point.]
- cf = conversion factor [gallons per cubic feet (gal/ft^3)] = 7.48 gal/ft^3 [In this equation, 7.48 gal/ft^3 is the necessary conversion factor.]

Monitoring wells are typically 2, 3, 4, or 6 inches in diameter. If the diameter of the monitoring well is known, there are a number of standard conversion factors which can be used to simplify the equation above.

The volume in gallons per linear foot, for various standard monitoring well diameters, can be calculated as follows:

$$v = nr^2\,(cf) \quad \text{[Equation 2]}$$

where:

- v = volume in gallons per linear foot
- n = 3.14

r = radius of monitoring well (feet)
cf = conversion factor (7.48 gal/ft^3)

For a 2-inch diameter well, the volume in gallons per linear foot can be calculated as follows:

$$v = \pi r^2 (cf) \quad \text{[Equation 2]}$$
$$= 3.14 (1/12\ ft)^2\ 7.48\ gal/ft^3$$
$$= 0.1632\ gal/ft$$

Remember that if you have a 2-inch diameter well, you must convert this to the radius in feet to be able to use the equation.

The volume in gallons per linear foot for the common size monitoring wells are as follows:

Well Diameter	(volume in gal/ft.)
2 inches	0.1632
3 inches	0.3672
4 inches	0.6528
6 inches	1.4688

If you utilize the conversion factors above, Equation 1 should be modified as follows:

Well volume = (h)(v)[Equation 3]

where:
h = height of water column (feet)
v = volume in gallons per linear foot as calculated from Equation 2

13.1 Computer Hardware and Software

Monitoring well locations (groundwater sample points) and drinking water sample locations may be located using the Trimble Pro XRS or GeoExplorer Global Positioning System (GPS) receiver. Prior to conducting field work, Trimble Pathfinder Office 2.51 (Pathfinder software) may be used to generate a data dictionary to be used during collection of sample locations. The data dictionary is then transferred from the computer to the GPS datalogger. Upon returning from the field, GPS data are downloaded from the GPS datalogger to a computer using the Pathfinder software. GPS data undergoes differential correction, with base station data obtained from a variety of community base stations depending upon geographic location to improve location accuracy. Pathfinder is used to export GPS data in variety of formats [i.e. ArcView shapefile, ARC/INFO, dBASE, and AutoCAD export (DXF) files]. Typically, GPS data are exported into dBASE files, and then manipulated withing Microsoft Excel 2000 software. Data are then manipulated where they can be utilized in site diagrams to display sample locations.

13.2 Data Management and Records Management

Field observations made during the sampling event will be recorded in a site logbook and/or field data sheets, including description of sampling locations and any deviations from the site-specific SQAPs. Chain-of-custody will be maintained until samples are relinquished to a courier or to the laboratories assigned to perform the analyses. Photographs will be taken to document site conditions. The location and direction from which photographs are taken will be noted in the field logbook, in accordance with the scope of work. Reports, site file memoranda, figures, tables, boring logs, etc. will be saved in site-specific Technical Direction Document (TDD) directories.

14.0 Quality Control and Quality Assurance Section

This section describes quality control/quality assurance (QA/QC) pertinent to groundwater and drinking water samples, and the types and uses of the QA/QC samples that are collected in the field. QA/QC samples are analyzed to provide information on the variability and usability of environmental sample results. They assist in identifying the origin of analytical discrepancies to help determine how the analytical results should be used. They are used mostly to validate analytical results.

A data quality review of the laboratory sample analyses will be conducted by U.S. EPA.

Field duplicates (replicates), matrix spike/matrix spike duplicate (MS/MSD), trip blanks, and rinsate (equipment) blanks are discussed below. QA/QC results may suggest the need for modifying sample collection, preparation, handling, or analytical procedures if the resultant data do not meet quality assurance objectives.

14.1 Field Replicates

Field replicates are used to assess the degree of sample heterogeneity, and the reproducibility of the sample collection procedure and the laboratory analysis. Field replicates are typically collected with groundwater and drinking water samples which are submitted for site assessment scoring activities. One field replicate is typically collected for each matrix type and sample parameter for Site Assessment scoring activities.

14.2 Laboratory Matrix Spike and Matrix Spike Duplicate

MS and MSD samples are used to monitor laboratory performance. MS/MSD samples are spiked in the laboratory with a known concentration of a target analyte(s) to verify percent recoveries. It may be necessary to provide extra volume of a sample to the laboratory for spiking analyses. Extra volume for MS/MSD analyses is collected for every 20 samples of each matrix for each requested analytical parameter.

14.3 Trip Blanks

Trip blanks are used to assess the degree of contamination introduced into samples during sample handling, shipment and analysis. Contamination may be introduced from the sample bottle, the preservatives used, cross-contamination (in the case of VOCs), or from shipping and handling, both in the field and in the laboratory. Trip blanks are typically collected for VOC analysis. Trip blanks (organic-free water) will be collected prior to the sampling event. Trip blanks will consist of certified clean water. Each bottle of the trip blank sample will be preserved with one drop of 1:1 HCl per 20 ml of sample to achieve a pH < 2. Trip blanks are handled, transported, and analyzed in the same manner as the other samples collected for that analysis that day. One set of trip blanks is collected for VOC analysis for each cooler in which VOC samples are shipped.

14.4 Rinsate (Equipment) Blanks

Dedicated or decontaminated sampling equipment will be used at each groundwater sample location to minimize cross-contamination. Groundwater sampling equipment must be decontaminated prior to the start of sampling activities as well as between sample locations, unless the sampling activity is dedicated to one sample location. Rinsate blanks are used to assess contamination (typically, cross-contamination) brought about by improper decontamination procedures between sampling stations. Rinsate blanks are not required for dedicated, disposable sampling implements. Examples of equipment requiring decontamination include submersible pumps.

Rinsate blanks are obtained by running analyte-free water through decontaminated sampling equipment to test for residual contamination. The water is collected into the appropriate sample containers, which are handled (e.g., preserved), shipped, and analyzed identical to the samples collected that day. Where non-dedicated sampling equipment is used, rinsate blanks must be collected at the rate of one per day per 20 stations for each parameter for which surface or subsurface samples are collected.

14.5 Temperature Blanks

Temperature blanks provide information on the preservation (temperature) of the samples during shipment to the laboratories. Temperature blanks are obtained by pouring tap water into a 40-ml glass vial and placing one temperature blank per cooler of samples.

15.0 Reference Section

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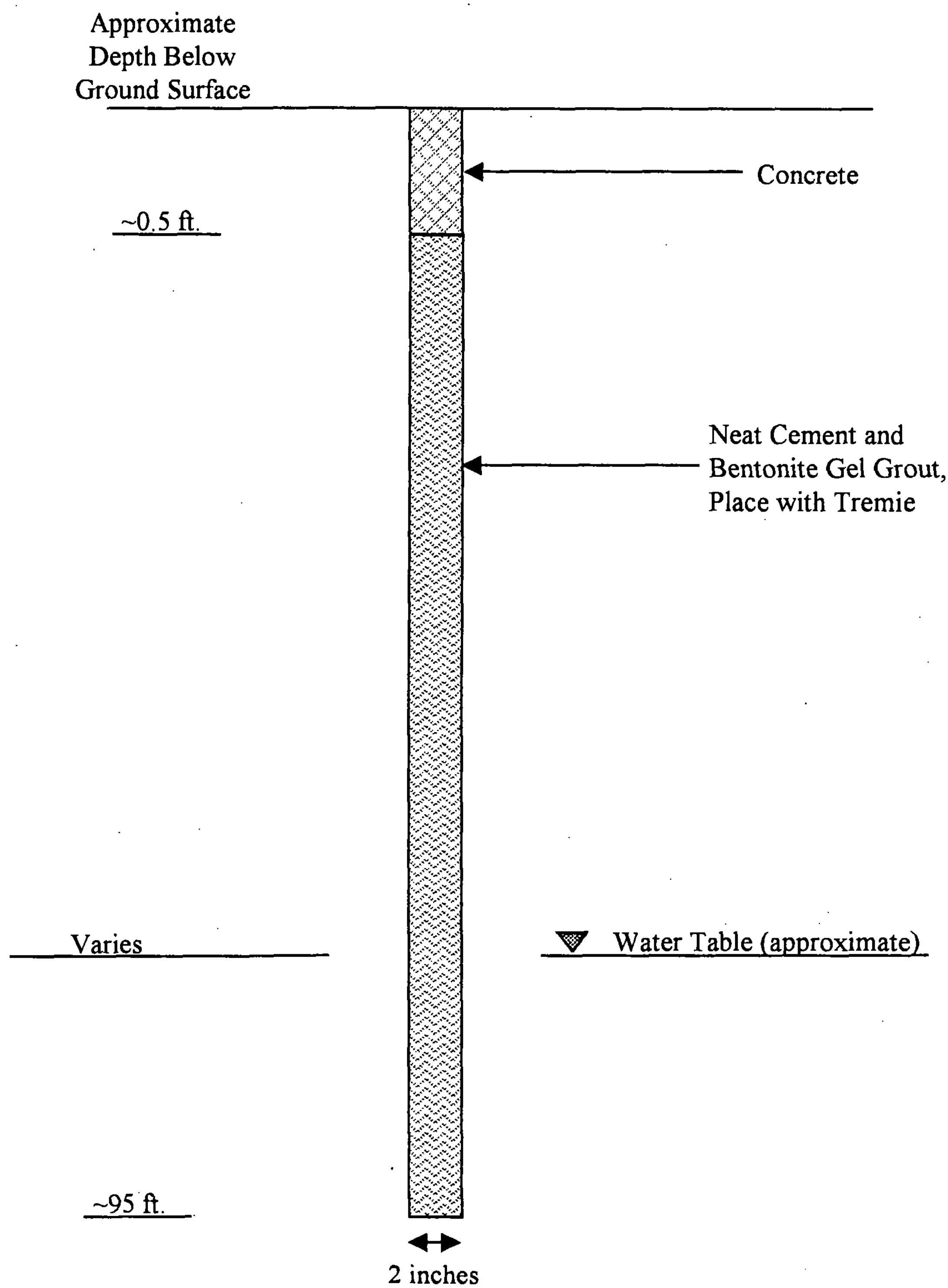
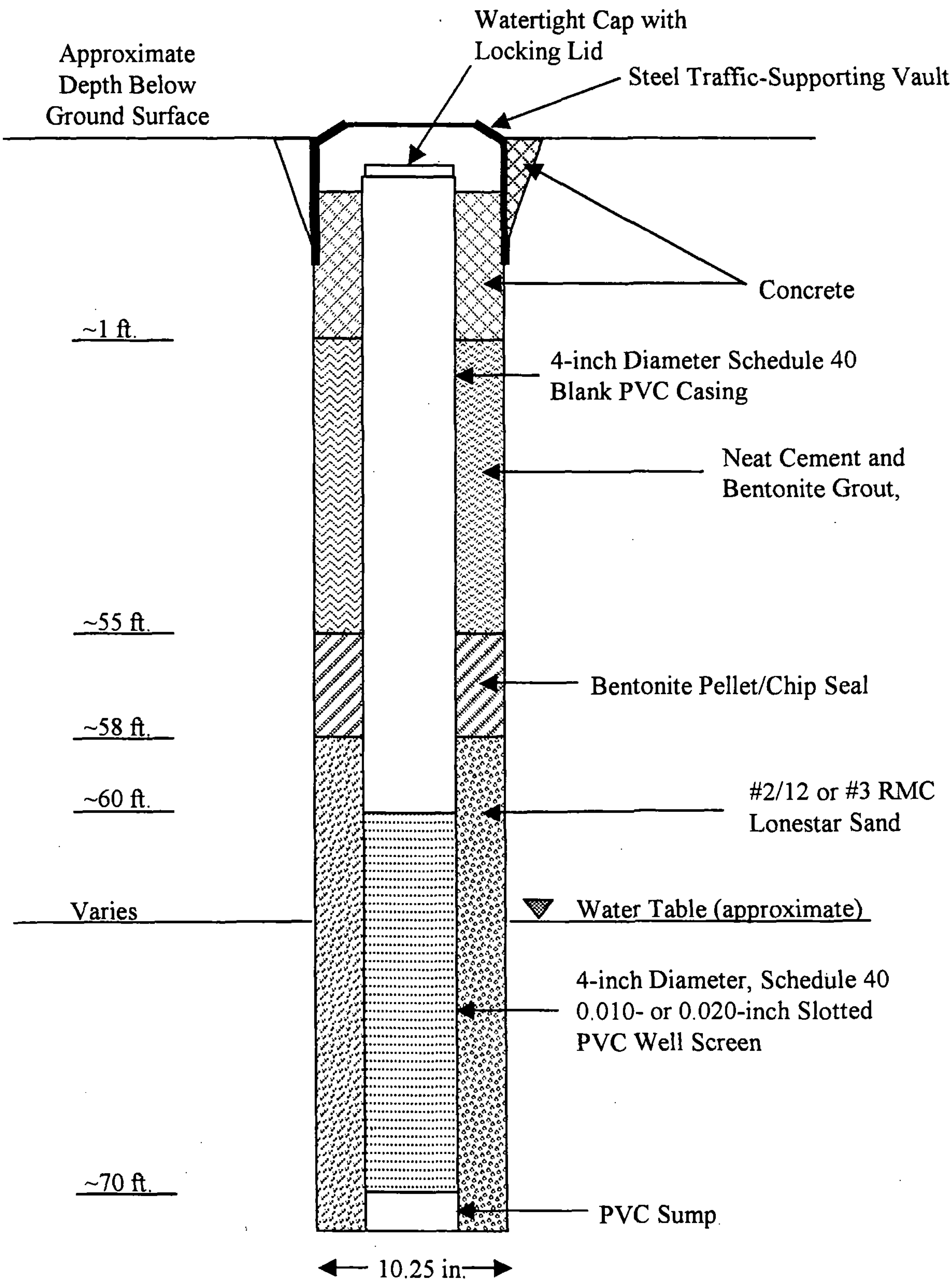
Appendix B

Typical Direct-Push Groundwater Sampling Boring Abandonment Diagram



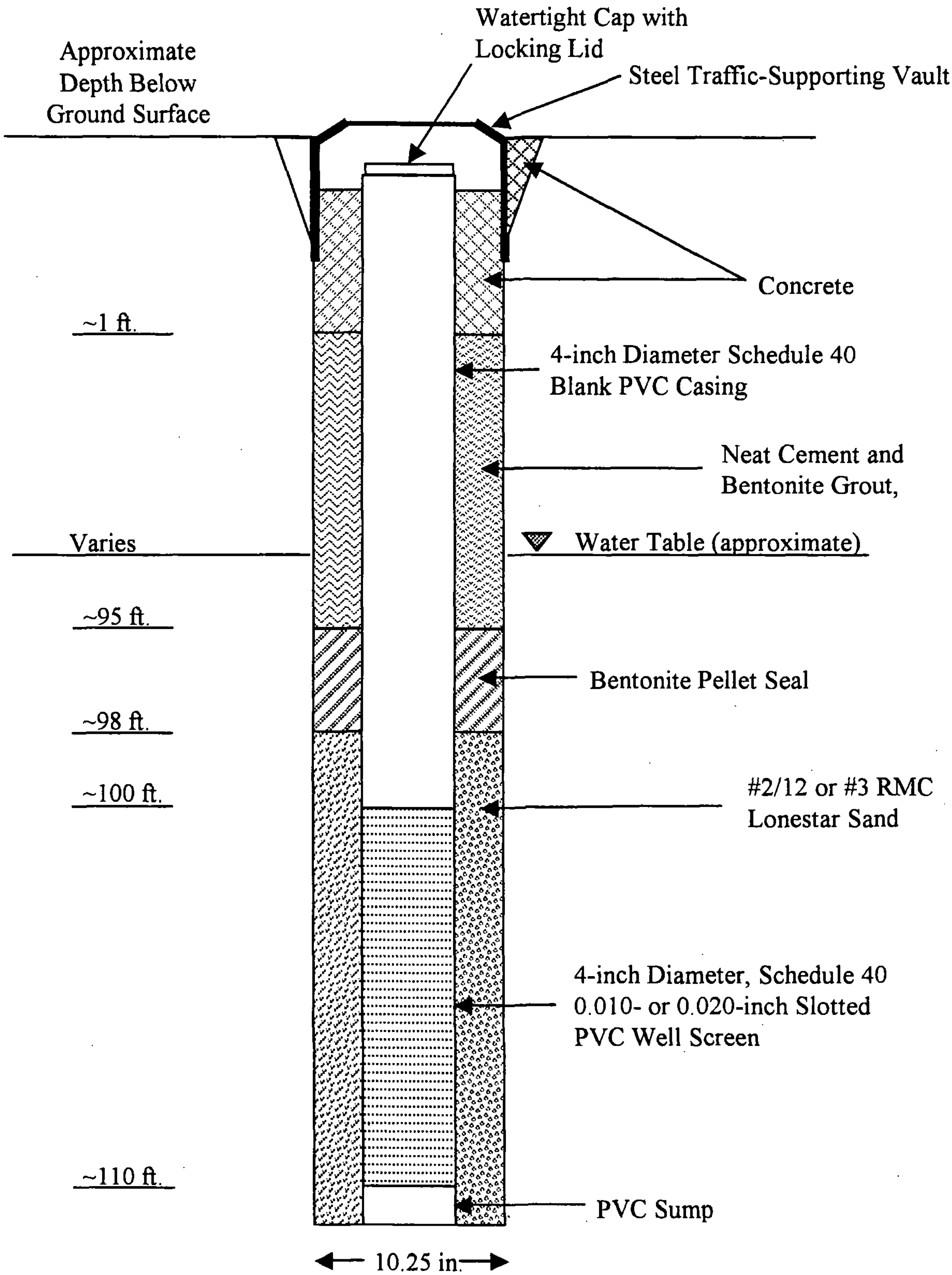
WESTON

Typical Well Construction Diagram, Shallow Wells



WESTON

Typical Well Construction Diagram, Intermediate Wells



WESTON

Typical Well Construction Diagram, Deep Wells