Final Plan for RI Follow-up to the P/S Landfill Seismic Refraction Survey

June 29, 2007

CASMALIA SITE REMEDIATION PROJECT

June 29, 2007

Corey Bertelsen
Project Manager

To: Russell Mechem – EPA
Rich Hiett - EPA

Subject: Final Plan for RI Follow-up to the P/S Landfill Seismic Refraction Survey

The Casmalia Steering Committee (CSC) submitted a draft *Plan for RI Follow-up to the Seismic Refraction Survey* (Plan) to EPA on May 22, 2007. EPA provided comments on that draft Plan in a letter dated June 13, 2007. The CSC is submitting this Final Plan incorporating EPA's June 13th comments on the draft as requested in EPA's letter. The final Plan, which was prepared with the assistance of our contractor Mactec, summarizes the follow up RI work (including the installation of CPTs and piezometers) that the CSC is proposing to use to evaluate whether there are any depressions in the HSU clay contact under the Pesticides/Solvent (P/S) Landfill. The CSC has used Mactec in the past at the site to install similar CPTs and piezometers.

The Plan that includes the following information (1) a summary of the proposed work and an evaluation of whether the CSC will perform the series of CPT pushes along the Bench roads (2) a map showing the planned piezometer locations and (3) detailed references to the RI/FS Work Plan for the work procedures.

This Plan discusses the completion of four CPTs and the installation of four piezometers (including piezometers RIPZ-13 and RIPZ-27 which were previously proposed in the RI/FS Work Plan along with two new piezometers RIPZ-38 and RIPZ-39) that will be placed at the specific locations that EPA identified in their May 4th letter as potential depressions or low spots in the HSU clay contact under the P/S Landfill. The detailed work procedures for the CPT and piezometer installations are discussed below and were originally provided in RI/FS Work Plan Appendices and Standard Operating Procedures (SOPs), including SOPs 3-1 and 4.1. Piezometer RIPZ-14 was installed in 2006 at Bench 5 of the P/S Landfill using these procedures.

<u>Proposed Seismic Refraction Follow Up Work</u>

The CSC is proposing the follow up work discussed in this Plan to resolve the issue of whether there are any closed depressions in the clay contact under the P/S Landfill that have trapped DNAPL.

This Plan is formatted similar to the earlier EPA approved Phase II and Phase III RI sampling memorandums which were in turn intended to be consistent with the June 3, 2004 Final RI/FS Work Plan. The Plan summarizes the program we intend to complete, provides the locations for the CPTs and piezometers, and refers back to the applicable SOPs of the revised Final RI/FS Work Plan that we will use to complete the CPTs and install and develop the piezometers.

The schedule for the proposed CPT and piezometer work is tentatively set for late July. Once we get approval of this proposed plan of work activities we will confirm that schedule with EPA in advance of the work.

CPTs

EPA's May 4, 2007 letter requested that the CSC "*please evaluate the series of CPT pushes recommended in the INL Report along each of the three roads (Gallery Well, Bench 1, and Bench 2) are appropriate to assess the optimum locations of the three recommended piezometers*".

The CSC has reviewed the INL Report provided to us with EPA's May 4th letter that is the basis for the agencies request for this seismic refraction follow up work. As we understand INL's geophysical analysis of the seismic refraction survey that the CSC completed, INL suggests there might be depressions in the HSU clay contact at three locations under the P/S Landfill, including an area west of the Gallery Well, an area immediately north of a former CPT location (LA-01) along the Bench 1 road, and an area adjacent to the Bench 2 road. The INL Report describes each of these potential locations as pronounced and closed depressions and INL provides a mapping of the elevation of the clay contact which suggests that the areal extent of the depressions are as large as 100 by 200 feet with a depth of depression which is anywhere from 15 to 20 feet lower than the surrounding elevation of the clay contact.

If the INL analysis is accurate, we should be able to confirm these robust depressions with a single instrumented CPT push that will ground truth the actual elevation of the clay contact at that location. Given the magnitude of the size of the suggested depression, the CSC does not believe that a series of CPT pushes is required and notes that each of these pushes means at least one penetration of the P/S Landfill cover or liner which must subsequently be repaired. We do agree with EPA that a CPT push, located in the middle or deepest part of the depression INL suggests exists, would provide a useful verification of whether the INL modeling is accurate.

As such, the CSC proposes to complete an instrumented CPT push at the locations we plan to install subsequent piezometers on the Gallery Well, Bench 1, and Bench 2 Roads. The three proposed CPTs will be completed according to SOP 4-1 of the RI/FS Work Plan (which we have attached to this Plan). That SOP provides the details of the instrumentation and tools that we will use to record the pertinent data required to identify the depth or elevation of the HSU clay contact. The CSC will use the information developed earlier in the RI program (and reported in the Interim Progress Report) regarding CPT signatures at the clay contact to determine the clay contact depth under the P/S Landfill. Pushing the proposed CPTs will meet the requirement of SOP 3-1 that we will be following for installing a piezometer in the footprint of a landfill (please see the discussion of piezometer installation below).

The location of the above three CPTs are shown on Figure 4.1-Seismic Followup which is attached to this memorandum. The locations of all of the proposed CPTs as shown on Figure 4.1 will be sited in the field using a GPS system to ensure they will be installed in the potential low spot locations identified in EPA's analysis. The CSC and representatives for EPA will walk the proposed locations for these CPTs prior to completing the work to agree on these final locations.

Piezometers

EPA's May 4, 2007 letter requested that the Plan describe the piezometers we propose to install and include the basis of the piezometer design (depth, screen interval), specifications of the proposed CPT rig, the procedures for pushing an initial instrumented CPT followed by installation of a piezometer, and the procedures for development of the piezometer.

As we noted above, the CSC is proposing to install three piezometers along the Gallery Well bench, Bench 1, and Bench 2 of the P/S Landfill. The three proposed piezometers will be installed and developed according to SOP 3-1 of the RI/FS Work Plan (which we have attached to this Plan). That SOP provides the details of the procedures and tools that we will use push the piezometer. We have attached *Table 1-P/S Landfill Piezometer Specifications* to this Plan that provides EPA the details of the anticipated depth and screen intervals of the two piezometers. Per the June 13, 2007 EPA Comment 10 the piezometer screen lengths will be increased from 10 to 20 feet.

The locations of these three piezometers are shown on Figure 4.1-Seismic Followup. The three locations are located within the deepest portions of the depressions that INL's analysis suggests exist.

EPA's May 4, 2007 letter also requested that the CSC install a piezometer located directly across from the Gallery Well to measure DNAPL depth in the Gallery Well area. The approved RI/FS Work Plan already proposed a piezometer for measuring DNAPL at that location (RIPZ-27) and provided the details (SOP, etc) for how that piezometer would be installed. The CSC agreed with EPA to defer the installation of that piezometer until we had resolved the issues with the seismic refraction survey and agreed to the installation of the piezometers we have discussed above.

The CSC has scheduled to install RIPZ-27 after we have completed the piezometer RIPZ-38 that we have proposed west of the Gallery Well and discussed the results of that work with EPA. We are scheduling RIPZ-27 to occur after RIPZ-38 because if we did find that INL's analysis was correct and that the Gallery Well is not located over the deepest portion of a depression in the clay contact at the toe of the P/S Landfill as INL suggests, we may want to install RIPZ-27 in a different location than the RI/FS Work Plan had proposed.

Documentation

The CSC will document the data collected from this Seismic Refraction RI Follow Up work using the same procedures and requirements as were required by the June 3, 2004 revised Final RI/FS Work Plan and the previous RI Sampling memorandums.

The project documentation requirements of the RI/FS Work Plan are specifically discussed in Section 11.2 of the Work Plan. All data collected during the CPT and piezometer installation will be discussed in the final RI Report.

Field Supervision and Coordination with EPA

The CSC is planning that the CPT and piezometer work will be performed by Mactec. Mactec previously installed RIPZ-14 in the P/S Landfill using the same SOPs and procedures as we have proposed for this additional work. At this time we expect to have the CSC's Project Coordinator onsite to provide supervision of Mactec while they are in the field.

In accordance with Section A6.1 of the RI/FS Work Plan we will notify EPA's on site representative of our plans to conduct the sampling at least five days in advance of beginning the work. The CSC will coordinate any field work with EPA using the same guidelines that are discussed in Section 11 of the June 3, 2004 RI/FS Work Plan that we had established for the Phase I RI work. That coordination specifically includes the requirements to coordinate with EPA as discussed in Section 11.3 of the Work Plan (and in Section A6.1 of the Sampling Analysis Plan or Appendix A of the Work Plan) and to hold daily status meetings as discussed in Section 11.5 of the Work Plan. EPA oversight personnel will be provided full access to the CPT Rig during CPT and piezometer installation as long as there are no safety precautions that would require otherwise. In addition, the CSC will continue to use the management of change procedures that we had agreed with EPA prior to beginning the Phase I RI work (please see Section 11.7 of the Work Plan). Any change in the procedures that are discussed above will be documented in an approved RICH form.

regards,

Corey Bertelsen
Casmalia Project Coordinator

Attachments

- Table 1- P/S Landfill Piezometer Specifications (rev 06.25.07)
- Figure 4.1- Seismic Followup (rev 06.25.07)
- SOP 4-1
- SOP 3-1

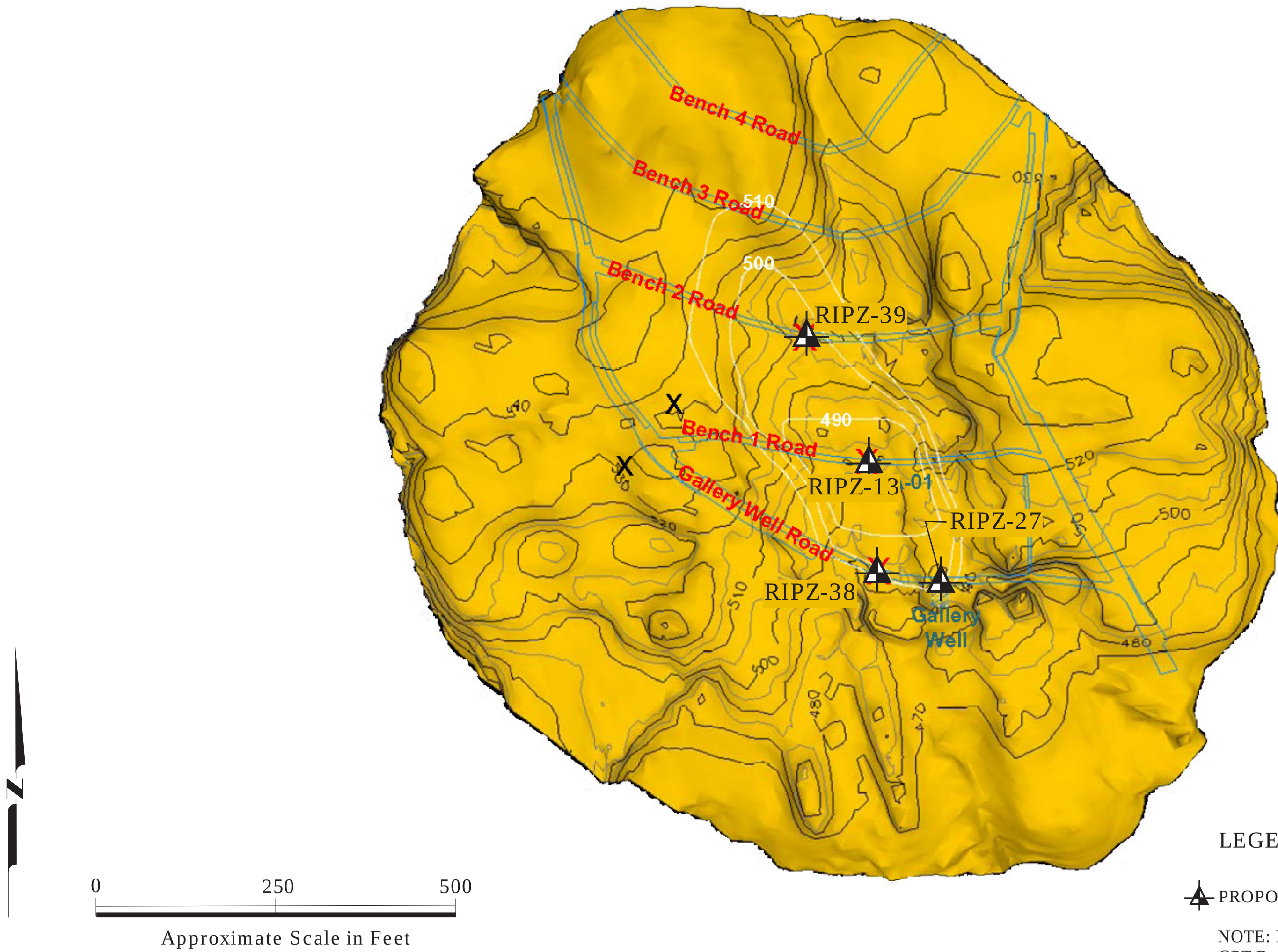
cc Jim Dragna – BM
Glenn Anderson – Chevron
Dave Roberson - ExxonMobil
Dan Niles – RWQCB
Caroline Rudolph – DTSC
Mark Wuttig – CH2MHill

Table 1. P/S Landfill Piezometer Specifications for Seismic Survey Followup
Casmalia, California

Name	Approximate Location	Drilling Method	Estimated Depth to Contact (ft. bgs)	Approx. Boring Depth Below Grade (ft. bgs)[1]	Depth To Water (ft bgs)	Well Construction Details				Well Development Method
						Borehole Diameter (inch)	Well Casing Type	Well Diameter (inch)	Screened Interval[2]	
RIPZ-13	Bench 1 on PS Landfill (replacement of PZ-LA-01)	CPT[2]	94	100	60	2.5	stainless steel/PVC[3]	3/4	10 ft of screen; just above unweathered bedrock contact; 74-94 feet	Airlifting
RIPZ-27	Just north of Gallery Well	CPT	80	80	40	2.5	stainless steel/PVC[3]	3/4	10 ft of screen; just above unweathered bedrock contact; 60-80 feet	Airlifting
RIPZ--38	West of Gallery Well along bench road	CPT	80	80	40	2.5	stainless steel/PVC[3]	3/4	10 ft of screen; just above unweathered bedrock contact; 60-80 feet	Airlifting
RIPZ-39	Bench 2 on PS Landfill	CPT	120	120	100	2.5	stainless steel/PVC[3]	3/4	10 ft of screen; just above unweathered bedrock contact; 100-120 feet	Airlifting

Notes:	1 - Feet below ground surface.	CPT Rig Weight - 35 tons.
	2 - Cone penetrometer test rig.	CPT Rig Length - 32' Highway, 34' 4" Offroad.
	CPT will be pushed into unweathered bedrock to confirm the depth to contact.	CPT Rig Width - 8' 2" Highway, 8'6" Offroad.
	The piezometer screen interval depths will be based upon the CPT identified depth to unweathered bedrock.	CPT Rig Travel Height - 11' 5" Highway, 13' 10" Offroad.
	Stainless steel pre-fabricated casing and screen will be used.	CPT Rig Work Height - 12' 6" Highway, 14' 10" Offroad.

Casmalia P/S Landfill



LEGEND

PROPOSED CPT AND PIEZOMETER LOCATIONS

NOTE: Piezometers will be installed in a single CPT Boring at the locations shown.

MACTEC	Seismic Follow Up Casmalia Site Remediation Casmalia, California		PLATE 4.1
DRAWN: CN	JOB NUMBER: 4098042051 5000.3	CHECKED:	CHECKED DATE: 05/07
APPROVED:	APPROVED DATE:		

STANDARD OPERATING PROCEDURE 3-1
WELL AND PIEZOMETER INSTALLATION AND DEVELOPMENT
CASMALIA SITE REMEDIAL INVESTIGATION

Prepared by: Dan Craig, MACTEC	June 25, 2007
Approved by: Corey Bertelsen, CSC	Revision 3.0

PURPOSE AND SCOPE

Wells and piezometer installation and development will include drilling, core-logging, downhole logging, construction, and development. The purpose of this work is to install and develop additional wells and piezometers from which groundwater data and subsurface lithologic and hydrogeologic information will be collected at the Casmalia Resources Disposal Site. Wells will be installed to augment the existing groundwater monitoring network and collect additional hydraulic and water quality data that will be used to evaluate the effectiveness of the current groundwater monitoring system. Piezometers will be installed to augment the existing groundwater water level monitoring network and collect additional hydraulic data that will be used to better define and monitor the distribution of hydraulic head at the Site and refine the Hydrogeological Conceptual Site Model. This work is being performed as part of the Remedial Investigation/Feasibility Study (RI/FS) that is currently being performed for the Site by the Casmalia Steering Committee (CSC).

Wells and piezometers will be drilled, logged, and constructed according to information provided in the attached Table A1-2 that indicates: (1) the proposed well or piezometer, (2) the anticipated depth to the weathered bedrock contact, (3) anticipated well construction details, (4) planned downhole video and/or geophysical logging method(s), and (5) the approximate depth intervals where coring and downhole geophysical work will be performed.

This SOP is to be used in conjunction with the SAP/FSP (Appendix A of the RI/FS Work Plan). In addition to the SAP/FSP, the following SOPs should be consulted:

- SOP 1-1 – Mechanical Drilling and Soil Sample Collection
- SOP 1-7 – Soil Logging
- SOP 4-1 – CPT / UVIF / MIP Profiling and Soil Sample Collection
- SOP 5-3 – Field Screening and Monitoring
- SOP 5-4 – Decontamination
- SOP 5-5 – HDPE Cap Penetration Repair and Testing

Also refer to the following supporting documents:

- Site Health and Safety Plan (HSP – Mactec, 2003)
- Job Hazard Analyses (Appendix C of the RI/FS Work Plan)

- ASTM Standard 2488-69 Standard Recommended Practices for Description of Soil (Visual-Manual Procedure)
- Howard, A.K., January 1986, Visual Classification of Soils - Unified Soil Classification System, Geotechnical Branch Training Manual No. 5, Geotechnical Branch, Division of Research and Laboratory Services, Engineering and Research Center, Bureau of Reclamation, Denver, Colorado
- ASTM Standard 2487-83 - Standard Test Method for Classification of Soils for Engineering Purposes

RESPONSIBILITIES AND QUALIFICATIONS

The PM is responsible for assigning project staff to complete well and piezometer installation and development, and assuring that this and any other appropriate procedures are followed by all project personnel at the site.

The project staff assigned to install and develop wells and piezometers are responsible for completing their tasks according to this and other appropriate procedures. All staff are responsible for reporting deviations from the procedure or nonconformance to the PM or project quality assurance/quality control (QA/QC) officer.

Only qualified personnel shall be allowed to perform this procedure. At a minimum, staff qualified to perform these activities will be required to have:

- Read this SOP
- Indicated to the PM that all procedures contained in this SOP are understood
- Completed the OSHA 40-hour training course and/or 8-hour refresher course, as appropriate
- Completed fit testing for full face respirator within one year prior to well and piezometer installation and development activities
- Read the Health and Safety Plan
- Previously performed installation and development of wells and piezometers in a manner generally consistent with the procedures described in this SOP
- A minimum of one year experience performing well and piezometer installation and development activities

Project staff who do not have previous experience performing well and piezometer installation and development activities will be trained on site by qualified personnel, and will be supervised directly until they have demonstrated an ability to perform the procedures.

PROCEDURES FOR WELL AND PIEZOMETER INSTALLATION AND DEVELOPMENT

Procedures for well and piezometer installation and development include drilling, core logging, downhole logging, construction, and development. Wells will be constructed in accordance with the State guidance "*Monitoring Well Design and Construction for Hydrogeologic Characterization*," June 1995. For some of these tasks, procedures to be followed will be the same or similar for both wells and piezometers, and for other tasks, the procedures will differ as described below.

3.1 Equipment List

The following equipment/materials will be required for well/piezometer installation. The appropriate level of PPE will be determined based upon field monitoring results, and in accordance with the procedures specified in the Health and Safety plan.

- Appropriate type and size drilling rigs
- Appropriate core or sampling bits, barrels, and shoes
- Appropriate downhole logging rigs
- Development SMEAL rig
- Poly tank
- Steam cleaner
- 2 and 4-inch diameter Schedule 40 PVC blank well casing
- 2 and 4-inch diameter Schedule 40 PVC 0.050 or 0.040-inch slotted screen
- 2 and 4-inch diameter Schedule 40 threaded and slip caps
- Stainless steel screws
- Medium Aquarium Sand
- Bentonite chips or pellets
- Bentonite Gel
- Portland Cement
- Approximate 8-inch diameter steel monuments
- 3KA model Master Locks keyed to 3210
- Soil color chart
- Core boxes
- Baggies
- Appropriate meters for development parameters
- Water level probe

- Oil interface probe, where needed
- Visqueen or other plastic sheeting
- Full Face respirator, where needed
- Tyvek coveralls, latex gloves, steel toed neoprene boots
- Photoionization detector (PID) equipped with 11.7 eV lamp
- Air compressor
- Tubing
- Narrow diameter bailer
- Cooler with ice
- Visqueen or other plastic sheeting
- Roll-off bins for drill cuttings and drums for PPE
- Field documentation forms

3.2 Drilling Procedures

Drilling activities will be directed by a geologist, hydrogeologist, or geotechnical engineer who will be responsible for supervising drilling, logging the samples, preparing the boring logs, directing well construction and preparing well installation diagrams. Drilling personnel will be required to wear appropriate personal protective equipment and follow the Site Health and Safety Plan.

The following are protocols for drilling wells, deep piezometers, shallow piezometers, and wells installed within the Landfill footprints. All chemical quality wells will be installed using air rotary drilling methods. All of the wells could potentially be used for the detection of NAPL at the Site. The air rotary method should minimize borehole compression or smearing of the borehole wall that could otherwise inhibit the flow of NAPL into the casing.

3.2.1 Drilling Wells and Deeper Piezometers

1. Chemical quality well and deep piezometer (>50 feet bgs) boreholes will be drilled using an air rotary system. Approximate 8.5-inch and 6.5-inch diameter borings will be drilled for chemical quality wells and piezometers, respectively.
2. Air will be used as the circulating medium; no drilling fluid additives or other chemical substances will be used or introduced into borings, well materials, grout, backfill, groundwater, or surface water unless specifically required and/or approved by the Site geologist, hydrogeologist, or geotechnical engineer.
3. If necessary to remove cuttings and minimize dust, clear onsite water from the fire hydrant northwest of the Operations Building may be used if deemed necessary by the Site geologist, hydrogeologist, or geotechnical engineer and documented in the field logbook. Due to the low recharge rate at the project site, introduction of the

water will be minimized as much as possible. All water introduced to the borehole will be tracked via an isolated totalizer affixed to the driller's water truck.

4. Prior to drilling activities, where site water might be used, a sample of the fire hydrant water will be collected for volatile and semi-volatile organic analysis, and total dissolved solids. The laboratory results will be made available to EPA onsite personnel.
5. If necessary, bentonite pellets no larger than 3/8-inch diameter may be used to backfill the bottom of the boring if it is determined that the total depth of the constructed piezometer or well will be less than the total depth of the driven hole.

3.2.2 Shallow Piezometers

1. Direct Push Technology (DPT) will initially be attempted to install shallow piezometers (those approximately 50 feet bgs or less). Approximately 2.5-inch diameter push rod will be driven approximately 5 feet into the top of the unweathered claystone at the new piezometer locations listed in Table A1-2.
2. If necessary, bentonite pellets no larger than 3/8-inch diameter may be used to backfill the bottom of the boring if it is determined that the total depth of the constructed piezometer will be less than the total depth of the driven hole.
3. No drilling fluid additives or other chemical substances will be used or introduced into piezometer borings unless specifically required and/or approved by the geologist, hydrogeologist, or geotechnical engineer. Use of water during drilling must be first approved by geologist, hydrogeologist, or geotechnical engineer and documented in the field logbook.

3.2.3 Piezometers Within Landfill Footprints

Piezometers located within Landfill footprints will be installed using a cone penetrometer test (CPT) rig. CPT will be used to reduce potential exposures to high concentrations of chemical contaminants during advancement of the borehole and casing. The CPT holes will initially be advanced using a 1.5-inch OD diameter push rod. While the CPT probe is advanced, the following measurements will be collected: friction ratio, local friction, tip resistance, sleeve resistance, pore pressure, differential pore pressure ratio, soil behavior type, and SPT N. The CPT data will be used to assess the depth of the fill and depth to the unweathered bedrock contact.

For CPT borings, where core samples will not be collected, the HSU contact depth will be inferred based on tip resistance signature, as described in detail in the RI/FS Work Plan Appendices. Previous CPT data including Phase 1 and Phase 2 RI piezometer installations in and adjacent to the Landfills have indicated the Upper-Lower HSU contact surface can be determined based on a sharp increase in tip resistance to greater than 500 tons per square foot and rig refusal. The Phase 1 RI CPT data signatures were described in Appendices E, K, and M of the *Interim Progress Report* and *IPR Addenda* and will be used to identify the HSU contact depths for the Phase 2 Landfill piezometers.

In the Phase 1 CPT borings, the HSU contact was inferred based on a sharp increase in tip resistance, generally from less than 200 to over 500 tons per square foot over a depth interval of a few feet. The HSU contact was inferred present at the bottoms of the Phase 1 Landfill piezometers and confirmation CPTs (RICPTs) and good correlation was made with contact depths logged in drilled boreholes adjacent to the confirmation CPTs. The contact was also inferred present at the bottoms of Phase 2 Landfill piezometer RIPZ-13

The target depth of wells installed using CPT will be determined by considering: anticipated depth to contact, the CPT results, and the downward refusals of the CPT rig.

Proposed Phase 2 piezometers including RIPZ-13, RIPZ-27, RIPZ-38, and RIPZ-39 will be installed in potential low spots identified during the Phase 2 Seismic Survey. The purpose of these piezometers as described in Sections 4 and 5 of the RI/FS Work Plan is to obtain liquid level data in potential low areas where the HSU Contact surface may be depressed and where DNAPL may have accumulated. The locations and target depths of these piezometers are described in the CSC's Draft Plan for RI Follow-up to the P/S Landfill Seismic Refraction Survey dated June 25, 2007.

3.2.4 Cased Piezometer and Well Borings

1. Drilling will not proceed below the upper hydrostratigraphic unit (HSU) in areas of known or suspected contamination unless temporary steel casing has been set to the base of the upper HSU to minimize the downward migration of shallow groundwater during drilling.
2. If monitoring of the water level in a boring indicates the absence of groundwater in the upper HSU, then temporary steel casing may not be necessary.

The following are procedures for drilling cased well or piezometer borings.

1. A pilot borehole will be drilled and cored from the ground surface to approximately 10 feet into the unweathered claystone.
2. The pilot hole will be opened with a 10 ½-inch diameter bit and 11 ¾-inch OD drive casing with a 10 ¾-inch ID to approximately 13 feet into the unweathered claystone. The temporary casing will be advanced until the casing shoe is set a minimum of ten feet below the top of the unweathered claystone, leaving three feet of 10 ½-inch diameter open hole beneath the casing shoe. Any sloughed material will be cleaned out of the hole. Teflon tape and environmentally safe Teflon pipe compound will be added to all threaded connections to ensure the connections are water tight.
3. Bentonite chips or pellets will be poured through the temporary drive casing until the open borehole beneath the casing shoe and a minimum of three feet of temporary casing are filled.
4. Water will be added to the bentonite and allowed to sit until hydrated as determined by a control sample monitored at the ground surface.
5. 7 5/8-inch OD temporary steel drive casing (with 6 5/8-inch ID) will be placed inside the 11 ¾-inch OD drive casing after the bentonite has hydrated. Teflon tape and pipe

compound will be added to the threaded connections. In addition, waterproof pipe wrap will be added to the outside of each connection.

6. PVC pipe will be strapped to the inside of the temporary inner drive casing to act as a centralizer to ensure that the inner pipe is plumb and centered within the outer drive casing.
7. The 7 5/8-inch OD temporary drive casing will be advanced until the shoe is even with the bottom of the bentonite seal (three feet below the outer casing shoe).
8. Prior to advancing the boring, side-scan video will be used to verify that no leakage is occurring into the inner casing.
9. Once the bentonite is fully hydrated, a pilot boring will be cored through the bottom of the bentonite to the anticipated total depth of the boring following the procedures previously described.

3.2.5 Management of Drill Cuttings

Drill cuttings from the borings will initially be separated and placed into separate (clean and contaminated) roll-off type bins at the Site.

1. Drill cuttings will be segregated into clean and contaminated, based on boring location, observations made in the field and PID readings.
2. At the completion of drilling, samples of drill cuttings will be collected for disposal profiling purposes and based on results, cuttings will be handled accordingly.
3. Cuttings will either be disposed of off-site (if warranted), or incorporated into future onsite construction activities as previously approved by EPA for previous site drilling efforts.
4. All free water will be removed from soil bins prior to collection of disposal profiling samples.
5. Free water will be pumped into the PSCT surge tank or other appropriate holding tank for subsequent treatment through the PSCT GAC treatment process.

3.2.6 Coring for Wells and Piezometers

One of two methods will be used to core the deep piezometers and well borings. The technique selected will be based on the type and condition of formation materials encountered in the boring. Based on previous drilling experience at the Site, the following methods are expected to achieve the best core quality. Other techniques may be developed in the field, as necessary, to optimize core quality. These methods will be documented in the field log book.

1. Use of a three-piece shoe in conjunction with a 94-mm spring retracted non-face discharge stratapack bit. The core generated by this method may result in more intact core samples, but could cause significant core glazing on the outside of the sample.
2. Adding a lead lip shoe (no protrusion) to the face discharge stratapack.

The coring method for shallow piezometers installed outside of the Landfill footprints consists of pushing approximately 2.5-inch OD steel push rods equipped with approximately four-foot length acetate liners into the formation. Piezometers installed within the Landfill footprint will not be cored.

1. The acetate liner is filled with sample material as the rod is driven into the ground surface.
2. The liner is subsequently removed while the outer push rod remains in place.
3. Additional push rods and fresh acetate liners are affixed to the pipe string until the target depth is reached or refusal due to formation resistance.

A "test core" will be collected under EPA oversight when the first chemical quality well or piezometer is drilled for the RI program to demonstrate that acceptable quality cores can be retrieved using the procedures described above. If the EPA is not satisfied with the coring procedure and quality of the core, a second core will be collected from a boring drilled adjacent to the well in question using a modified procedure approved by the EPA onsite representative.

3.2.7 Headspace Screening

To assist in the characterization of soil contamination, headspace screening of soil and weathered rock samples will be performed using a photoionization detector (PID).

1. Headspace PID measurements will be collected from samples collected at the ground surface to 30 to 40 feet into unweathered bedrock, or as applicable based on borehole conditions.
2. The PID will be equipped with an 11.7 electron-volt (eV) lamp. Headspace PID readings will be documented on boring logs.
3. Headspace screening will be performed as described below:

   i Remove a portion of formation material from the core barrel and immediately place it in a clean glass jar with a stem cap.

   ii After allowing the samples to sit for a minimum of five minutes and not more than ten minutes in an area of constant temperature, insert the PID probe into the stem cap. The probe will measure the concentration of volatile organic compounds in the headspace.

   iii Record the maximum value measured in the headspace on the soil boring log.

   iv After taking the PID measurement, place the screening sample contents with the borehole cuttings.

   v Calibrate the PID twice daily in accordance with the manufacturers' recommendations; once in the morning and then once at midday, and any time that there is evidence that the readings are not stable or repeatable.

3.2.8 Borehole Washing of Wells and Deeper Piezometers

Upon completion of lithologic coring activities, the drill pipe and coring assembly will be removed and the borehole opened to the appropriate diameter (typically 6.5 inches for piezometers and 8.5 inches for wells) using an air rotary tri-cone rock bit or similar equipment. The borehole sidewalls for wells and piezometers drilled into the Lower HSU and any well or piezometer drilled to depths of twenty or more feet below the weathered un-weathered contact will then be flushed with rig water to facilitate easier and more productive geophysical and video logging.

1. Flushing of the sidewalls will be conducted prior to downhole and sidescan video logging, optical/acoustic televiewer logging, and other geophysical logging by circulating rig water through the drill pipe and up through the annular space of the borehole to dislodge formation-derived clays and muds that could otherwise obscure the geophysical and video logging.
2. Water generated during flushing activities will be containerized within the same roll off bins as downhole generated fluids and cuttings and subsequently pumped into a container for treatment through the PSCT GAC treatment system. The volume of water introduced as a result of borehole washing will be tracked and recorded in the field log and lithologic log sheet.

3.3 Downhole Logging

3.3.1 Lithologic Logging

Well and piezometer boreholes will be lithologically logged by a field geologist or engineer under the supervision of a California-registered geologist. Soil will be described in accordance with the Unified Soil Classification System (USCS) and standard geologic logging techniques. Rock samples will be described following the format used by the U.S. Department of Interior Bureau of Reclamation (Engineering Geology Field Manual). Each log will also identify the logger’s name and the date and time of the logging. Protocols for lithologic logging are provided in SOP 1-7.

3.3.2 Video and Geophysical Logging

To assist in characterization and the determination of screened intervals, selected boreholes will also be video and geophysically logged as appropriate upon completion of drilling activities. The purpose of continuous coring, video logging, and geophysical logging is to attempt to identify the locations of lithologic contacts, fracture zones, and zones where the formation produces water. This information will be used in determining the well design. Table A1-2 lists downhole geophysical logging methods planned for the wells and piezometers installed as part of the RI/FS. The planned downhole geophysical logging methods are described in the SOP for borehole geophysical logging.

3.4 Piezometer and Well Installation

The following describes procedures for deeper piezometer and well installation. Screened intervals will target the first fractured zone that appears to produce water on the basis of coring, video, and geophysical logging results. Special considerations; e.g. UVIF readings or observations on cores, will be taken considering that wells may be used for the detection of NAPL. All decisions regarding screened intervals for both chemical quality wells and piezometers will be made in consultation with EPA's onsite representative (CH2MHill). A summary of coring, video, and downhole geophysical logging results will be provided to EPA's representative for discussion and interpretation prior to finalizing well/piezometer construction details and completing the well or piezometer. Diagrams showing typical well and piezometer construction details are attached to this SOP. As discussed below, CPT will only be used to install wells within the landfill footprint. CPT will not be used to install wells outside of the landfill because subsurface core samples cannot be retrieved for logging and evaluation of subsurface conditions.

1. Wells will be constructed using 4-inch diameter Schedule-40 flush-joint threaded PVC blank and factory-slotted (0.050 inch) casing inserted with the slotted interval adjacent to the zone to be monitored. This design has been effective in producing groundwater at the site with minimal siltation of the wells. This is based on a review of existing well and piezometer construction. The majority of wells on-site are constructed of:

    - 2- and 4-inch Schedule 40 PVC Casings
    - 0.050-inch slotted PVC screens
    - #4 Monterey Sand or Monterey medium aquarium sand

    Threaded end plugs will be used at the bottom of the wells. Slip caps will be used to cover the top of the well. Generally, 10 to 20 feet of PVC screen with a slot size of 0.050-inch will be installed at the base of each well. The depth and location of the well screen will be based on the depths where water yielding fractures were observed in cores and video logs. Stainless steel centralizers will be attached above and below the screened section of the PVC casing in the borehole.

2. Deeper Piezometer casing will consist of 2-inch diameter flush-threaded schedule 40 PVC. Threaded end plugs will be used at the bottom of the piezometers. Slip caps will be used to cover the top of the piezometer. PVC screen section, with a slot size of 0.040-inch or 0.050-inch, will be installed at the base of each piezometer, such that the slotted interval is adjacent to the upper HSU or lower HSU zone to be monitored. Generally, the screened section will range from 5 to 15 feet and will be installed adjacent to the water-yielding fractures, as assessed from video logs and cores. Stainless steel centralizers will be attached above and below the screened section of the PVC casing in the borehole.

3. Shallow piezometer casing (if DPT is successful) will consist of 3/4-inch ID flush threaded stainless steel or Schedule 40 PVC. In areas outside of landfill footprints, the

4. In areas within the landfill footprint, shallow piezometer casing (consisting of ¾-inch ID flush threaded stainless steel or Schedule 40 PVC) will be pushed using a CPT rig. As described in Section 3.23, CPT pilot holes will first be driven using an approximate 1.5-inch OD diameter push rod to assess the depth of the piezometer based on inferred depth to the bottom of the fill and weathered bedrock. After the pilot CPT borehole has been advanced to the targeted depth, the CPT drive pipe will be removed and approximately 2.5-inch diameter pipe with a disposable tip will be driven to the target depth (assessed by the CPT results). A prefabricated well consisting of ¾-inch ID well casing, screen, sand pack, and bentonite seal will be installed within the drive pipe. The top of the prefabricated screen, sand pack, and bentonite seal will be threaded into the bottom of a prefabricated plug installed to keep grout from reaching and damaging the bentonite seal and sand pack. The top of the plug will be threaded into flush threaded stainless steel ¾-inch ID blank casing extending to approximately three feet above ground surface. The annular space surrounding the blank flush-threaded pipe will be backfilled with bentonite/cement grout poured from the surface through the 2.5-inch diameter push rod, if possible. During grouting activities, the 2.5-inch diameter push rod will be lifted and removed from the ground allowing the formation to collapse around the prefabricated screen, sand pack, and bentonite seal. The CSC will endeavor to geophysically log the piezometer holes using a “pencil-thin” gamma tool (16 mm diameter) to assess whether or not the formation has collapsed around the prefabricated screen, sand pack, and bentonite seal. The CSC will exercise extreme caution during logging because even a slight borehole deviation could cause the tool to stick in the hole. The logging operation will be abandoned if the piezometer holes are not suitable. It should be noted that the logging tool manufacturer, Mount Sopris Instrument Co., does not recommend logging 3/4 –inch ID holes with its “pencil thin” gamma tool.

5. Care will be taken to maintain tension on the casing string in the borehole during construction of the well or piezometer. The driller will avoid placing excessive lateral stress on the casing. Stainless steel or PVC centralizers will be attached to the PVC casing to assure well/piezometer plumbness in the borehole (centralizers will not be used on DPT piezometers). Centralizers will be fastened to the casing above and below the screened section for wells or piezometers greater than 20 feet in length.

6. Only clean, manufacturer-packed, silica sand will be used to construct the sand pack (pre-packed sand/filter pack and bentonite seals will be used for those piezometers installed using DPT). This sand will have an appropriate size gradation to allow less than 2 percent of the sand pack to pass through the well screen slots (such as Monterey medium aquarium sand). A sand pack sample will be retained for possible chemical analysis if anomalous water quality results are obtained from the well.

7. The sand pack material will be placed to prevent bridging of the material in the annulus or damage to the well/piezometer screen or casing. For well or piezometer depths greater than approximately 50 feet, the sand pack will be placed with a tremie pipe. The sand pack will extend from the bottom of the borehole to approximately three feet above the top of the well screen.

8. At least three feet of bentonite pellet seal will be placed immediately above the sand pack to prevent intrusion of the overlying bentonite-cement grout material into the sand pack. The bentonite seal will be allowed to hydrate sufficiently before subsequent placement of grout. The seal may be constructed using bentonite pellets, chips, or thick bentonite slurry. Bentonite pellets will be placed in a cup and hydrated (or slurry will be mixed) at the same time the down hole bentonite seal is hydrated to accurately gauge proper hydration of the seal.

9. The annular space above the sand pack and seal will be filled with a cement-bentonite grout. The grout will be pumped through a tremie pipe or hose, if the fall is greater than 20 feet. Care will be taken to prevent or minimize grout penetration into the underlying bentonite seal. After the grout has set, it will be inspected for shrinkage and additional grout added, if necessary.

10. At locations where piezometer clusters are proposed (multiple piezometers at different depths within approximately 25 feet of each other) staging of the grout placement may be conducted if subsurface conditions warrant. Staging of grout placement will be performed to reduce the potential for grout to travel along fracture sets and into adjacent piezometer screened sections. After the grout has set, it will be inspected for shrinkage and additional grout added, if necessary.

11. In double cased wells or piezometers, once the well or piezometer has been installed and the hole has been grouted most of the way up, the temporary casing will be removed and the remaining annular space will be grouted to the ground surface.

12. An approximate eight-inch diameter protective lockable steel casing and concrete pad will be installed around each well and piezometer. The protective cover will be secured with a lock keyed with the Site master well key. The protective casing will subsequently be painted and stenciled to identify the well or piezometer ID number. The wells will be surveyed and marked for future groundwater elevation monitoring. This information will be documented for each well and piezometer on completion logs.

13. The well/piezometer installation and construction details will be recorded on the borehole log, including:

    - Bottom of the boring
    - Casing diameter
    - Screen interval and slot size
    - Description of sand pack
    - Bentonite seal

- Grout
- Centralizers, if necessary
- Casing stickup

3.5 Well and Piezometer Development

A description of the development procedures for chemical quality wells and piezometers is described below. Development will be completed using a well development rig. Development will be supervised by the Site geologist, hydrogeologist, or geotechnical engineer who will be responsible for making sure that accurate water quality parameters are collected. Water quality meters will be calibrated each morning and documented onto field notes. The following are procedures for well and piezometer development:

1. Measure the total depth of the well/piezometer and depth to water and using these data, calculate the volume of water in the well or piezometer casing. Compare the total depth to well/piezometer logs to assess whether sediments have accumulated on the bottom of the well or piezometer.
2. If necessary, use a bailer to remove any sediment in the bottom of the well/piezometer.
3. After the well/piezometer is reasonably clear of sediment, lower a surge block into the well/piezometer and raise and lower it several times (swabbing) across the entire length of the screened portion of the well or piezometer. Swabbing will agitate the sand pack and formation to draw undesirable fines (fine sand, silt, and clay particles) into suspension in the well/piezometer column.
4. Bail particulates from the well or piezometer.
5. Continue swabbing and bailing until the volume of fines is significantly reduced.
6. Purge the well/piezometer with a submersible pump until:
    - The water appears free of sediment
    - Water quality parameters have stabilized. The well is considered stabilized when successive parameter measurements are within ten percent of each other.
    - At least three well volumes have been purged or well continually pumps dry.
7. If clear, sediment free water can not be obtained, remove additional casing volumes of water, if possible.
8. For each casing volume of water removed, measure water quality parameters (pH, specific conductance, turbidity, Eh, dissolved oxygen (DO) and temperature) and record the parameters on the well development log. Water quality parameters will be measured in the following units:
    - Temperature °C = Degrees Centigrade
    - Conductivity umhos/cm = micromhos per centimeter

- pH 1-14
- Turbidity NTU
- ORP millivolts (mV)
- DO milligrams per liter

9. Record water level readings during development in order to gauge draw down of water within the well/piezometer casings.
10. In piezometers or wells where the recharge of water in the casing fails to keep up with draw down of the water table by the bailer (low yield), continue development over a period of several days. If insufficient water recovery occurs after several days, wells or piezometers will be considered to be developed even though clear, sediment free water may not have been obtained. A submersible pump may not be appropriate for use during the development process of low-yield piezometers or wells.
11. Temporarily store the water purged from the wells and piezometers in a portable storage tank, drums, or equivalent. The water will be treated in the PSCT GAC Treatment System.
12. For shallow piezometers installed using ¾-inch ID casings, aggressive well development will be performed using air lift techniques described below or by bailing using an appropriately sized bailer. The development program will be conducted over a realistic period of time to maximize the volumes of liquids removed from each piezometer and develop strong hydraulic gradients in the vicinity of the piezometer screens to overcome potential capillary forces associated with potential NAPL presence.

    - A small-valved recovery head will be installed on the top of the 1-inch OD casing. The head will be equipped with approximate 3/8-inch tubing which will be lowered to the bottom of the well casing. Air will be introduced at the bottom of the well using a compressor. The compressor will be located downwind of development activities.
    - Development water will be airlifted up the annular space of the well casing and through an approximate ½-inch diameter hose affixed to the recovery head. Water will be discharged into a graduated tank. Surging of the well casing will be performed by raising and lowering the bottom of the downhole air tube across the length of the sand pack.
    - Introduction of air into the well column will stop once fluids from the well are no longer being brought to the surface. The well will then be allowed to recover before development activities continue.
    - Vapors collected in the tank will be scrubbed through one 55-gallon vapor carbon at piezometer locations installed within landfill footprints.
    - Air-lifting of each shallow piezometer will be performed at least 4 times a day for a period of up to four days. Due to the relatively low permeability of the aquifer materials, it is anticipated that only partial recovery of liquid levels will occur

between lifts in most of the piezometers, and more frequent air lifting will not be effective. For piezometers exhibiting relatively good hydraulic performance and quick recovery rates, more frequent air lifting up to six times a day will be performed for a period of four days.

- Clean downhole tubing will be used for each piezometer to be developed.
- Water level measurements will not be collected from piezometers under development once airlift development activities begin because downhole tubing will remain in the well casing. Recovery rates will be calculated based on the volume of water generated for each time the well is air lifted. Depth to water will be measured upon completion of development activities after the downhole tubing has been removed.
- Parameter measurements will not be collected in wells installed within the Landfill footprint.
- Piezometers outside Landfill footprints will be developed using an appropriately sized bailer. Wells developed using a bailer will follow similar protocols as for larger diameter wells.

3.5 Decontamination

The drill rig, drilling and sampling equipment, and downhole geophysical equipment will be decontaminated using protocols in SOP 5-4 – Equipment Decontamination. All screens, casing, and fittings will be factory cleaned and packaged or will be decontaminated on Site, if necessary.

3.6 Well Survey

Piezometer and well casings will be surveyed for elevation, northing, and easting coordinates in accordance with SOP 5-2 – Field Sample Location and Surveying.

3.7 Documentation

The following information will be documented on boring logs and well development forms:

Boring Logs:

- Boring number and location
- Weather conditions
- PID meter readings
- Water conditions (including measured water levels)
- Drilling method and bore hole diameter
- Blow counts for standard penetration tests

- Core and split-spoon recoveries
- Name of contractor, driller, and rig geologist
- Zones of water loss or production during drilling
- Date and time of start and completion of each boring
- Dimensions and depths of well construction materials
- Diameter, gauge, and depth of conductor casing, if used
- Sampling depths
- Downhole logs conducted
- Total depth of the boring
- Formation contacts
- Lithologic descriptions
- Water levels during drilling, including occurrence of first water

Well Development Forms:

- Water levels prior to and during development
- Casing volume calculations
- Amount of water bailed and pumped
- Parameter (pH, specific conductance, turbidity, Eh, dissolved oxygen (DO) and temperature) measurements, time measured, and quantity of water purged immediately prior to measurement.

STANDARD OPERATING PROCEDURES 4-1
CONE PENETROMETER TESTING (CPT) / ULTRA VIOLET INDUCED FLUORESCENCE (UVIF) / MEMBRANE INTERFACE PROBE (MIP) PROFILING AND SOIL SAMPLE COLLECTION CASMALIA SITE REMEDIAL INVESTIGATION

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1.0 PURPOSE AND SCOPE

This standard operating procedure (SOP) establishes the requirements and procedures for conducting cone penetration testing (CPT), ultraviolet induced fluorescence (UVIF), and membrane interface probe (MIP) measurement techniques and CPT soil sample collection during the Remedial Investigation/Feasibility Study (RI/FS) at the Casmalia Site. CPT offers an alternative to conventional drilling methods by enabling rapid, high quality subsurface exploration and soil sampling to obtain detailed stratigraphic and hydrogeologic data, while significantly reducing site disturbance and waste generation. Combined, CPT/UVIF technology can be used to characterize soil properties, and assess preferential flow pathways and the qualitative distribution of light non-aqueous phase liquids (LNAPL) in vadose and saturated zone soils. MIP technology is being used to verify the results of the UVIF technology at selected locations across the Site.

For the Casmalia site, the CPT borings will be advanced to the top of the unweathered bedrock where UVIF data and pore pressure measurements will be used to identify zones where NAPL may be present. These data can then be used to select targeted sampling depths for CPT borings or other drilling techniques, and well installation depths using conventional drilling technologies.

This SOP is to be used in conjunction with the Sampling and Analysis Plan/Field Sampling Plan (SAP/FSP) (Appendix A of the RI/FS). In addition to the SAP/FSP, the following SOPs should be consulted:

- SOP 1-6 – En Core® Soil Sampling (for volatile organic compound analysis)
- SOP 1-7 – Soil Logging
- SOP 1-8 – Sample Handling/Preservation
- SOP 5-1 – Photo-documentation
- SOP 5-2 – Field Location / Surveying
- SOP 5-3 – Field Screening / Monitoring
- SOP 5-4 – Equipment Decontamination

All Field work will be conducted in accordance with the health and safety procedures outlined in the Site Health and Safety Plan (HSP - Mactec, 2003) and the Job Hazard Analyses (Appendix C of the RI/FS Work Plan).

2.0 RESPONSIBILITIES AND QUALIFICATIONS

The project manager (PM) is responsible for assigning project staff to complete these activities, and assuring that this and any other appropriate procedures are followed by all project personnel at the site.

The project staff assigned to CPT/UVIF/MIP profiling and sample collection are responsible for completing their tasks according to this and other appropriate procedures. All staff are responsible for reporting deviations from the procedure or nonconformance to the PM.

Only qualified project staff shall be allowed to perform this procedure. At a minimum, staff qualified to perform these activities will be required to have:

- Read this SOP and companion SOPs
- Indicated to the PM that all procedures contained in this SOP are understood
- Completed the Occupational Safety and Health Administration (OSHA) 40-hour training course and/or 8-hour refresher course, as appropriate
- Read Health and Safety Plan
- Previously performed CPT/UVIF/MIP profiling and sample collection in a manner generally consistent with the procedures described in this SOP
- A minimum of one year experience performing similar activities

Project staff who do not have previous experience with CPT/UVIF/MIP profiling and sample collection will be trained on site by qualified personnel, and will be supervised directly until they have demonstrated an ability to perform the procedures. An experienced subcontractor may be used for implementing the CPT/UVIF/MIP profiling and sample collection activities. The subcontractor should have at least one-year of experience performing similar activities. In this case, the staff fulfilling the first three prerequisites for qualification listed above will oversee the subcontractor's activities during field CPT/UVIF/MIP profiling and sample collection. The PM shall document personnel qualifications related to this procedure in the project QA files.

It is the responsibility of the field personnel to ensure that he/she has the forms needed for sample custody, that materials needed for handling, preservation, and packaging are brought to the site, and that the necessary arrangements are made for shipment prior to initiating an investigation.

3.0 PROCEDURES FOR CONE PENETROMETER TESTING, ULTRAVIOLET INDUCED FLUORESCENCE, AND MEMBRANE INTERFACE PROBE PROFILING AND SOIL SAMPLE COLLECTION

The following sections present equipment and procedures for CPT/UVIF/MIP field activities including CPT profiling, combined CPT/UVIF profiling, MIP profiling, and CPT soil sample collection.

3.1 EQUIPMENT LIST

It will be the responsibility of the subcontractor operating the CPT/UVIF/MIP equipment to provide the appropriate and necessary tools and equipment to advance a borehole, collect soil samples (or other matrix specific samples), and conduct CPT, UVIF, and/or MIP profiling as specified under the RI. The appropriate level of PPE will be determined based upon field monitoring results and in accordance with the procedures specified in the Health and Safety Plan. Typically, the subcontractor will provide the following:

- CPT rig, operator, equipment, and support tools to operate the CPT rig
- Appropriate probes for UVIF and MIP
- Mechanical sampling devices, such as continuous core soil samplers, direct push sampling rods and samplers, split spoon soil samplers, Shelby tube samplers, etc.
- Decontamination equipment and containment (including a high-pressure steam cleaner, rinse water containment trough, decontamination pad, storage tank, etc.)
- Containment for soil cuttings (forklift and tip dumpster, drums, etc.)

In addition to the equipment and materials provided by the subcontractor, the field staff will obtain the equipment/materials listed here. The appropriate level of PPE will be determined based upon field monitoring results and in accordance with the procedures specified in the Health and Safety Plan.

- Paper towels
- Location map
- Tape measure
- Self-adhesive sample labels
- Stakes or flags for marking sampling locations
- Field log book and/or data collection forms
- Site location map
- Sealable plastic freezer bags
- Personal protective equipment and monitoring equipment specified by the Health and Safety Plan for the potential chemical exposure and work being performed. At a

minimum, nitrile or powderless surgical gloves should be worn during sample collection and handling

- Chain-of-custody forms
- Ice chests/coolers
- Ice or frozen ice packs (blue ice)
- Pen with indelible ink

PROCEDURES

The CPT system incorporates a steel probe that is hydraulically advanced into the soil. The CPT lithologic logging system is truck-mounted and typically contains a 20- to 25-ton hydraulic push system. All boring activities are conducted within the enclosed CPT rig. This portion of the SOP is organized as follows:

- CPT Testing Methodology
- CPT/Ultraviolet Induced Fluorescence Testing Methodology
- CPT/Membrane Interface Probe Testing Methodology
- CPT Soil Sample Collection

3.2.1 CONE PENETROMETER TESTING METHODOLOGY

For stratigraphic exploration, the CPT procedure consists of pushing a cone-tipped cylindrical probe into the ground while simultaneously measuring the resistance to penetration (American Society for Testing and Materials [ASTM] Standard D 3441-86). The CPT probe contains two strain-gauge load cells that measure the soil-bearing resistance acting on the conical tip of the probe and the frictional resistance sensed along a friction sleeve. In accordance with ASTM Standard D5778-95, the cone is advanced at a rate of two centimeters per second with the driving force provided by hydraulic rams mounted in the CPT rig.

While the CPT rods are advanced, tip resistance (Qc), sleeve friction (Fs), and dynamic pore pressure (Ut) are measured, plotted, and digitally recorded, as a function of depth below ground surface. The measurements are recorded at 5-centimeter intervals, and transmitted as a voltage signal through a cable inside the hollow push rods to a computerized data acquisition system inside the CPT rig. The on-board computer stores the data for on-site plotting and interpretation. The combined data from the tip resistance and sleeve friction form the basis of the soil classification (e.g., sand, silt, clay, etc.), which is identified using Campanella and Robertson's Simplified Soil Behavior Chart.

Specific field procedures for using the CPT probe are identified in the following subsections:

Sample Locations. Sampling locations will be based on criteria presented in the SAP/FSP. Each sample location will be established based upon horizontal coordinates (in northing and eastings), surveyed, and marked as described in SOP 5-2 – Field Sample Location/Survey.

Field Set-up. Prior to implementing the CPT/ UVIF/MIP investigation, confirm with site personnel that underground utilities are not present.

Field Investigation. Field procedures will include:

1. Assemble equipment and check for proper operation
2. Decontaminate all equipment including drill rig and all associated equipment
3. Place equipment on clean, plastic sheeting until it is needed
4. Clear sampling location of all objects and utilities
5. Saw cut holes using a concrete coring contractor if sampling will take place on concrete surfaces
6. Inspect, clean, and put on appropriate PPE
7. Zero the computer system at ground surface prior to each CPT run
8. Advance boring using the truck-mounted hydraulic ram on the CPT rig
9. Record depths by the length and number of rods used during the CPT run. Remember to measure the length of each rod with the tape measure prior to use to ensure accuracy
10. Collect and record CPT data using the field logbook and/or data output from the CPT rig computer
11. Decontaminate the CPT push rods following completion of each boring following the procedures outlined in SOP 5-4 – Equipment Decontamination
12. Abandon the boring by filling the open borehole with a bentonite-cement grout. Fill the borehole from the bottom up using a tremie pipe
13. Patch the surface of the boring corresponding to the adjacent ground surface

3.2.2 CPT/UVIF TESTING METHODOLOGY

Combining the CPT probe with the UVIF probe allows simultaneous detection of both soil lithology and petroleum hydrocarbons in the soil. The CPT probe follows the procedures described above. The UVIF system consists of a down-hole mercury lamp that transmits ultraviolet light through a small diameter sapphire window mounted flush with the side of the CPT probe. As the probe is advanced, the ultraviolet light passes through the sapphire window and is absorbed by hydrocarbon molecules in contact with the window, causing them to fluoresce. A portion of the fluorescence is returned through the sapphire window and conveyed by a fiber optic cable to a detection system within the CPT rig. The fluorescence intensity is plotted continuously on UVIF logs.

The specific field procedures identified above for the CPT probe will also apply to using both the CPT and the UVIF probes at the same time. The only change is that separate instruments are bundled together in a single down-hole tool.

3.2.4 CPT/MEMBRANE INTERFACE PROBE METHODOLOGY

The MIP will be used at minimum of 6 to a maximum of 8 selected locations that may have high percentages of pure chlorinated solvents. If the UVIF tool indicates the presence of a DNAPL, the MIP profiling will be unnecessary. If the UVIF tool does not indicate the presence of a DNAPL at these 6 to 8 locations that are likely to contain DNAPLs, a follow-up MIP profile will be completed. A table that prioritizes the locations for potential MIP profiling is attached to this SOP as Table 4-1-1.

The MIP collects up to six channels of data at a time; these channels of data include three chemical data sets, electrical conductivity (EC), penetration rate, and temperature. The MIP will continuously monitor environmental conditions with depth using a photoionization detector (PID) and an electron-capture detector (ECD). The EC, penetration rate, and temperature data provided by the MIP will provide insight into the subsurface lithology and presence of saturated zones.

The MIP is a down-hole probe that consists of a heating block, a gas permeable membrane, and a gas loop to bring the gases that migrate across the membrane to the surface for analysis.

EC sensors are located near the leading tip of the probe. The measurements recorded by the EC sensors provide an indication of grain size and thus different soil strata. In addition, if contaminant concentrations are high enough, the EC sensors may also provide an indication of ion content and thus contaminant distribution with depth.

A rubber-coated transfer line protects the electrical conduit and gas lines and connects the probe to the surface analytical equipment. This transfer line is threaded through the rods that are used to push the probe into the ground. At the surface, the gases are delivered to a PID and an ECD, to measure total VOC response. This high productivity protocol is often adequate for locating VOC sources and mapping the extent of the compounds of interest. The PID is often used for aromatic compounds (e.g., benzene, toluene, ethylbenzene, and xylene), and the ECD is used for chlorinated hydrocarbons (e.g., TCE, PCE, CCl_4). The PID and ECD measure total VOCs and have a sensitivity of approximately 500 parts per billion (ppb).

The CPT operator will monitor the advancement of the probe and advise the MIP operator when refusal has been met. At this point, the rods will be removed from the ground, the hole sealed, and the vehicles will move to a new location.

The specific field procedures identified above for the CPT probe will also apply to the MIP probes. The only change is that the MIP does not require decontamination between sampling locations because contaminants are burned off as a result of the high operating temperatures used during operation of the MIP.

3.2.4 CPT SOIL SAMPLING

This section describes the procedures to be used for the collection of soil samples using the CPT rig, and includes identifying sample locations, field set-up, CPT soil sampling, and sample processing and handling. Prior to sampling, the necessary sampling tools and equipment will be assembled and checked for proper operation.

Sample Locations. Sampling locations will be based on criteria presented in the SAP/FSP. Each sample location will be established based upon horizontal coordinates (in northing and eastings), surveyed, and marked as described in SOP 5-2 – Field Sample Location and Surveying.

Field Set-up. Prior to implementing the CPT work, confirm with site personnel that underground utilities are not present.

CPT Soil Sampling. Soil sampling will typically follow the CPT analysis run. The following procedures will be used:

1. Soil sampling locations will be placed approximately 6 feet upgradient relative to the location of the previous CPT testing run.
2. The necessary sampling equipment shall be assembled and checked for proper operation before soil sampling. Soil sampling devices vary between subcontractors but most consist of a piston-type sampler with a retractable point and two inner liners or an acetate coring tube. The general sampling procedure will be as follows:
   - The soil sampling tool will be deployed using the CPT system to collect soil samples at the intervals specified in the Workplan, for visual inspection and/or chemical analysis
   - The soil sampling tool is pushed to the desired sampling depth with the drive tip locked in place to prevent soil from entering the sampler body

- At the desired sampling depth, the locking mechanism is released, causing the drive tip to retract inside the drive rod and seat above the liners/acetate tube
- The sampling device is subsequently pushed into the soil to collect a sample

3. Sampler retrieval is dependent on the subcontractor's equipment. The most common form of retrieval is achieved by pulling the drive rods from the sample location and unthreading the sampling tool from the rods.
4. Following retrieval, the liners/acetate tube shall be removed from the sampler and placed on a flat surface for evaluation. The top and bottom of the core and sampled interval will be marked on the liners/acetate tube.
5. The ends of each liner or sections of acetate tube containing soil to be submitted for analysis shall be covered with Teflon® film before being covered with plastic caps. Each submitted sample will be labeled with the boring number, bottom depth of liner, date and time of sampling, the individual performing the sampling, and job number in accordance with SOP 1-8 Soil Sample Handling, Preservation, and Shipping.
6. After sampling, the borehole will be backfilled with a cement bentonite grout. The grout will be introduced into the bottom of the borehole and filled to the surface using a tremie pipe and/or grout sleeve.
7. A description of the soil type encountered, sample depth and identification, surface conditions and observations, will be entered in the field log book and documented in the boring log (see SOP 1-7 – Soil Logging).
8. To prevent cross-contamination, the CPT drill rods and sampling equipment will be decontaminated between each sample and borehole following the procedure described SOP 5-4 Equipment Decontamination.
9. Before collecting the next sample, don a new pair of nitrile gloves.

4.0 DOCUMENTATION

The field documentation requirements for the CPT/UVIF/MIP supervisor/field staff will include recording all obser-vations made during field activities that could affect the quality of field data. The documentation should be entered in a field logbook with consecutively numbered pages and/or the data collection forms. Documentation should include at a minimum:

- Drilling/location/diagram or map
- Date of field activity
- Personnel on-site
- Time of day
- PPE level

- Borehole identification number
- Boring method
- Measured parameters
- Unusual conditions (e.g., presence of free product)
- Decontamination procedures
- CPT/UVIF/MIP readings
- PID/FID/ECD readings (as appropriate)
- Sample collection or measurement methods
- Number of samples collected
- Sample identification numbers
- Sample distribution (laboratory)
- Type of equipment in use
- Field observations and comments
- Boring logs
- A brief description of the area around the boring location and the weather conditions at the time of sample collection. Each entry (or page) in the field logbook should be dated and initialed by the individual making the entry
- Borehole abandonment procedures

Field forms that will be used for the RI are included as Attachment 2 of Appendix A.