	AIR MONITORING	Issued Date:	November 2009
		Revision:	1.0
		Approved:	John M. Bierschenk
			John M. Bierschenk, President

1 PURPOSE

To ensure that TerraTherm, Inc. (TerraTherm) follows a consistent program to monitor personal breathing space. The preferred monitoring method will be defined in the project specific work plan, sampling and analysis plan, and/or quality assurance project plan, but should be confirmed by the Project Manager prior to monitoring.

2 DISCUSSION

For the purpose of this Standard Operating Procedure (SOP), air monitoring may be perimeter monitoring, system vapor monitoring or personal air space monitoring. Each of these monitoring methods will be defined in the sections below. Additionally, calibration of volatile organic compound (VOC) instruments, such as hand-held Photo Ionization Detectors (PIDs), permanent PIDs, hand-held Flame Ionization Detectors (FIDs), permanent Continuous Emissions Monitoring Systems (CEMS), and compound specific Dräger pumps will also be discussed.

3 APPLICATION

Data collected in the field is used to identify any potential safety hazards; as well as evaluate the efficiency and progress of the remediation effort; therefore, it is extremely important that these data be reliable and accurate. This Standard Operating Procedure (SOP), although maybe not entirely, applies to most TerraTherm projects and the personnel responsible for the construction, operation and maintenance of them.

4 DEFINITIONS

Hand-held PID: Compact monitor designed as a broadband volatile organic compound (VOC) gas monitor and datalogger for use in hazardous environments. Depending on the unit, concentrations of gases can be detected from the sub parts per billion (ppb) to 10,000 parts per million (ppm).

Permanent PID: Similar to hand-held PID except instrument is permanently mounted to a fixed-point gas monitoring system.

Hand-held FID: Compact monitor best for detecting hydrocarbons, including methane, and other easily flammable components. Depending on the unit, concentrations of VOCs can be detected from 0.1 to 50,000 ppm. One drawback of the FID is that it destroys most - if not all - of the compounds it is detecting, making additional sample measurements impossible.

CEMS: A permanent flue gas analyzer designed to monitor VOC concentrations in hazardous environments.

Dräger pump: Manual gas detector pump that draws a calibrated 100 mL sample through a Dräger gas detection tube. Typical application is to monitor personal breathing space from airborne pollutants, rather than environmental sample medias.

5 CALIBRATION PROCEDURES

For maximum safety, the accuracy of the instruments should be checked by exposing them to a known concentration calibration gas before each day's use.

Calibrating the Hand Held PID

- Turn on the unit and allow to equilibrate for approximately 10-15 minutes.
- Press "Mode" and "N/-" keys together for about three seconds to enter the program menu.
- "Calibrate/Select Gas?" Press the "Y/+" key.
- "Fresh Air Cal?" Press "Y/+" key. Make sure the PID is connected to the fresh air source. Follow the instructions on the screen.
- "Span Cal?" Press the "Y/+" key.

- "Cal gas = isobutylene" "span value = 0100.0 ppm". These two entries must match the type of gas and concentration used for calibration.
- "Apply gas now" and follow instructions on screen. **Do not attach the canister of gas directly to the PID unless fitted with a 500 cc/min regulator; rather attach a dedicated Tedlar bag filled with calibration gas.**
- Note the reading (it should be within 10% of the calibration concentration). Disconnect from gas.
- Press MODE to exit programming menu.

Calibrating the Permanent PID

- Press above the "Mode" circle or the triangles labeled [+] and [-] keys to enter the program menu.
- Access the calibration menu by keying MODE.

The PID is calibrated using a two point calibration process. First, use a "zero gas"; then use a "span gas" of known concentration. Any gas can be applied, but the greatest accuracy comes from calibrating with the same gas as is being measured.

- "Calibrate/Select Gas?" Press the "Y/+" key.

Calibrating the FID

- Turn on the hydrogen
- Wait about three minutes for the hydrogen flow to regulate.

- Confirm the hydrogen flow by removing the exhaust port from the detector assembly and placing the inlet of the flow meter on the hydrogen outlet. The flow should read 13.9 mL/min +/- 0.5.
- Press the toggle switch to turn the unit on.
- Press the enter key.
- "Detector? Start Flame".
- Press enter to start the flame.
- Allow the unit to run for approximately five minutes.
- Press the "Cal" button.
- Select the Cal memory.
- Enter the desired response factor and press enter (usually 1.0).
- Select low or high range and press enter. Low range is for expected concentrations between 0.5 and 2,000 ppm (methane equivalents); high range is for expected concentrations between 10 and 50,000 ppm.
- Connect the zero air, carbon filter or fresh air and press enter.
- Enter the concentration of the span gas and press enter.
- Connect the span gas and press enter.
- After approximately 60 seconds, calibration should be complete.
- Remove the span gas.

Calibrating the CEMS

Some CEMS units have an automatic calibration function that enables the instrument to switch to locally stored standard gas cylinders and perform a span calibration without intervention. Other CEMS installations will require manual calibration at set intervals. Check with the operation manual and/or project manager prior to calibration.

Calibrating a Dräger pump

No calibration is needed; however, the counter, if present, shall be reset with each new Dräger tube insertion.

6 PROCEDURES

Data collected directly with the PID, FID, CEMS, or Dräger pump are typically used to evaluate personal breathing space. All of these instruments, with the exception of the Dräger pump, can be set to record total VOCs continuously while performing field duties.

Both the PID and FID can be easily placed and/or transported in or near work areas. Both instruments record continuously; typically displaying total VOC concentrations in parts per million (ppm). Both are programmed to alarm if total VOC concentrations exceed OSHA limits. If the alarm sounds, immediately move to fresh air and

contact the project manager for further instructions.

The Dräger pump is used to evaluate specific organic and some inorganic compounds. Specific compound tubes are placed into the pump. The pump, similar to an accordion, is squeezed several times (number determined by compound). The color change in the tube is evaluated against a color scale provided by the vendor. Should concentrations exceed project specific emission limits, or predetermined health and safety limits, immediately move to fresh air and contact the project manager for further instructions.

7 CALIBRATION RELATED FORMS

Included with this SOP are related calibration forms. It is important that calibration of these instruments be documented and retained on site through the life of the project.

8 SAMPLE RELATED FORMS

Total VOC readings shall be recorded in the project specific field book. Concentrations shall be recorded, at a minimum, hourly unless conditions warrant otherwise.

9 REFERENCES

RAE Systems, MiniRAE 2000, Operation and Maintenance Manual, Document: 011-4001-000, Revision E, May 2005.

RAE Systems, RAEGuard PID, FGM 1000 Series, Operation and Maintenance Manual, pn 033-4001-000, Revision B.

U.S. Environmental, Photovac Micro FID Maintenance and Calibration Guide.

10 RESPONSIBILITIES

The Site Supervisor, Site Safety Officer or the Project Manager will conduct periodic inspections of the sampling procedures established by this SOP. The purpose of the inspection is to verify that the procedures and the requirements of the SOP are being followed. Any deviations or inadequacies that are identified during the inspection will be immediately corrected.

	CALIBRATING THE NEPHELOMETRIC METER (LAMOTTE 2020**)**	Issued Date:	June 2011
		Revision:	2.0
		Approved:	John M. Bierschenk
			John M. Bierschenk, President

1 INTRODUCTION

This standard operating procedure (SOP) provides instructions for calibrating and using a Nephelometric meter, commonly referred to as a turbidity meter, which measures the "cloudiness" in groundwater and surface water samples. This SOP is written specifically for the calibration and use of the LaMotte 2020. Although other meters are available, TerraTherm prefers the LaMotte for its ease of operation, accuracy, and portability.

This instrument meets or exceeds United States Environmental Protection Agency (USEPA) design specifications for National Primary Drinking Water Regulations (NPDWR) and National Pollutant Discharge Elimination System (NPDES) turbidity monitoring programs as specified by the USEPA method 180.1.

Turbidity can be interpreted as an absence of clarity or brilliance. It is caused by suspended and colloidal matter such as clay, silt, organic and inorganic matter and microscopic organisms. Turbidity should not be confused with color since a dark(ly) colored water can still be clear but not turbid.

TerraTherm obtains turbidity data only to get a sense of the water's quality. Turbid water is often an indicator of conditions that may cause damage to, or interfere with operations of, the thermal processing equipment.

2 EQUIPMENT AND MATERIALS

The items listed in the following equipment and materials list are required to calibrate the LaMotte 2020 accurately in accordance with this SOP. It should be noted that different solutions may be required depending on the samples to be tested. Consult your project manager and/or quality assurance project plan (QAPP).

- LaMotte 2020 meter
- Turbidity tubes
- Deionized (DI) or distilled water
- Turbidity standards of 1.0 and 10 Nephelometric Turbidity Units (NTU), specific to the LaMotte meter
- Mild detergent such as Alconox
- Lint-free cloth (glass tissues, or similar)
- Nitrile disposable sampling gloves

- Write-in-the-Rain pen, or similar
- Field book or calibration form

3 CALIBRATION PROCEDURES

The LaMotte 2020 has been pre-calibrated by the factory in the range of 1 to 1100 NTU with AMCO™ primary standards manufactured by Advanced Polymer Systems, Inc. This allows the 2020 to be used for treated water, natural water or wastewater. Recalibration of the 2020 by the user is not required; however, it is TerraTherm's policy to calibrate the turbidity meter at least once a week. Calibration checks should be done, at a *minimum*, at the end of each sampling day **and** when readings become erratic. Consult your project manager and/or QAPP for the required calibration frequency.

Prior to calibrating the meter, the turbidity tubes shall be washed with a mild soap and thoroughly rinsed with DI water. Failure to do so could result in incorrect turbidity readings. The turbidity tubes must be clean from fingerprints, lint, dried spills and significant scratches. Inspect the tubes prior to use and wipe the tube clean with a lint-free cloth.

To calibrate the meter, don a fresh pair of Nitrile gloves and follow the steps below:

- Pour a small amount of a standard into a clean turbidity tube and swirl. Discard. Repeat two times.
- Fill the turbidity tube with the same standard, cap, and wipe the tube clean with a lint-free cloth.
- Open the lid of the meter. Align the indexing arrow mark on the tube with the indexing arrow mark on the meter, and insert the tube into the chamber.
- Close the lid. Push the READ button. If the value displayed is not the same as the value of the standard, calibrate as follows:
- Push the CAL button for at least five seconds (or until CAL is displayed on the screen). Release the button. The display will flash. Adjust the display with the up or down arrow buttons until the value of the standard is displayed.
- Push the CAL button again to memorize the calibration. The display will stop flashing when calibration is complete.
- Repeat for all standards.

4 FIELD MEASUREMENTS

Once the meter has been calibrated, field readings shall be obtained as follows:

- Fill a turbidity tube to the neck with sample, cap, and wipe dry with a clean, lint-free cloth.

- Open the lid of the meter. Align the indexing arrow on the tube with the indexing arrow on the meter. Insert the turbidity tube into the chamber.
- Close the lid. Push the READ button. The turbidity in NTUs will be displayed within five seconds.

5 TROUBLESHOOTING

Refer to the manufacturer's manual for assistance with troubleshooting.

	EQUIPMENT DECONTAMINATION AT THE SRSNE SUPERFUND SITE	Issued Date:	February 2011
		Revision:	1.0
		Approved:	John M. Bierschenk
			John M. Bierschenk, President

1 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to ensure that TerraTherm, Inc. (TerraTherm) follows a consistent program to decontaminate field equipment used during the drilling operations, system operations, and during site demobilization. This SOP specifically discusses procedures for when, where, and how to decontaminate the equipment at the SRSNE Superfund Site. Personnel involved in decontamination activities may be exposed to skin contact with contaminated materials and chemicals brought to the site as part of the project work; therefore, it is extremely important to follow these established decontamination methods including any health and safety protocols described in the site specific health and safety plan.

2 DISCUSSION

The objective of equipment decontamination is to remove potential site contaminants from the drilling equipment, including the rig and tooling, and the process system equipment. Equipment decontamination will be conducted after the drilling operations have been completed (prior to the rigs leaving the site);if NAPL is encountered during the wellfield installation; during thermal operations, if necessary; and, at the completion of the thermal remedy.

3 APPLICATION

This SOP, although maybe not in its entirety, applies to most TerraTherm projects and the personnel responsible for construction and operation efforts. It specifically addresses how to limit personal exposure to residual contamination that may be present on field equipment.

4 DRILLING EQUIPMENT DECONTAMINATION

The following guidelines must be followed when decontaminating drilling equipment. This includes tooling, rigs, and any support heavy equipment.

- A decontamination pad, or other appropriate containment system, shall be constructed prior to drilling efforts with polyethylene sheeting, or similar, in a location approved by the contractor. The pad shall be large enough to house the largest heavy equipment/vehicle that will be onsite.
- The decontamination pad will be inspected on a daily basis for evidence of leaks or loss of integrity to the containment system. Any deficiencies shall be immediately corrected.
- Gross decontamination shall be conducted by pressure washing.
- Fine decontamination shall be conducted using a manual scrub brush with a phosphate free detergent (such as Alconox or Liquinox).
- After washing with the water/soap mixture, rinse with water only.

- Allow the equipment to completely air dry.
- Record the decontamination procedure on the decontamination cleaning inspection log.
- Water that is generated by the decontamination system will be transferred to the onsite treatment plant for treatment and discharge.
- Personnel will discard all PPE used during the decontamination efforts in appropriately labeled drums staged near the decontamination area.
- Equipment will be determined “clean” through visual inspection.

5 PROCESS EQUPMENT DECONTAMINATION

During thermal operations, it may be necessary to decontaminate equipment that was exposed to contaminated soil or liquid. Similarly, once operations are complete, all equipment will be dismantled and decontaminated prior to leaving the site.

The procedures outlined above shall again be followed; however, it may not be necessary to construct a decontamination pad, but rather, the oil water separator will be used to capture and process any contaminants prior to being transferred to the treatment plant for treatment and discharge.

6 RESPONSIBILITIES

The Site Supervisor will conduct periodic inspections of the installation procedures established by this SOP. The purpose of the inspection is to verify that the procedures and the requirements of this SOP are being followed. Any deviations or inadequacies that are identified during the inspection will be noted and immediately corrected.

7 ATTACHMENTS

Decontamination Cleaning Inspection Log

TerraTherm, Inc.
SRSNE Superfund Site
Southington, CT

Decontamination Cleaning Inspection Log

Equipment	Pre-Entry Decon Activities Performed (if required)	Pre-Entry Inspection (Initial/Date):	Decon Activities Performed	Equipment Decon Inspection (Initial/Date):	Free Release Decon Activities Performed	Equipment Free Release from Site (Initial/Date):

	EMISSION SAMPLING	Issued Date:	December 2009
		Revision:	1.0
		Approved:	John M. Bierschenk
			John M. Bierschenk, President

1 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to ensure that TerraTherm, Inc. (TerraTherm) follows a consistent program in collecting emission samples.

2 DISCUSSION

For the purpose of this SOP, emissions sampling refers to vapor samples collected at the influent, midfluent effluent or any other location along the vapor treatment train. Sampling locations may be added, modified, or deleted depending on the treatment equipment at the site. Refer to the project Process and Flow Diagram for process equipment components, controls, and sample ports. Also for the purposes of this SOP, emissions sampling may also be referred to as vapor sampling.

This SOP describes sample collection into Tedlar™ bags, Summa canisters, or screening with a hand-held Photo Ionization Detector (PID).

3 APPLICATION

This SOP, although maybe not in its entirety, applies to most TerraTherm projects and the personnel responsible for vapor collection.

4 PROCEDURES

If collecting vapor samples in Tedlar™ bag for screening, connect both a moisture filter and a humidity filter to the calibrated PID prior to attaching to the collected sample. In general, a new humidity filter should be used for each day of sampling. If the humidity filter becomes discolored during sample collection, the filter should be replaced prior to collection of the next sample.

Collection into a Tedlar™ Bag

The vacuum pump, bag, and tubing shall be screened with a hand-held PID prior to sample collection. The pump can be screened by connecting a Tedlar™ bag to the vacuum pump with fresh Tygon® tubing and filling the bag with ambient air. Screen the bag by attaching it to the PID. The bag and tubing can be screened by attaching them (separately) directly to the PID.

If the PID detects concentrations above background in the pump, the pump shall be disassembled and cleaned. If the PID detects concentrations above background in the tubing, a fresh length of tubing shall be cut and used for sample collection.

Attach the sample location to the inlet of the vacuum pump with Tygon® tubing. Connect the outlet from the vacuum pump to a Tedlar™ bag. Ensure that seals do not leak. Place the vacuum pump at least three feet downwind of the field sampling team. Ensure that the valve on the sample location is closed. Turn the vacuum pump on and check that there are no leaks in the sampling equipment. Open the valve on the bag. Fill the bag to its full volume, being careful not to overfill and burst the bag. Once the Tedlar™ bag is full, close the sample port. Close the bag's inlet valve and disconnect the bag from the vacuum pump. Place the Tedlar™ bag in a warm room or car and allow approximately 10 to 15 minutes for the temperature of vapor in the bag to reach ambient temperatures. Once temperatures are ambient, attach the Tedlar™ bag to the PID. Record the maximum reading on the project specific Process Equipment Data Sheet.

Collection into Tedlar™ Bag using a Vacuum Chamber

The tubing shall be screened with a hand-held PID prior to sample collection. The tubing can be screened by attaching it directly to the PID. If the PID detects concentrations above background, a fresh length of tubing shall be cut and used for sample collection.

Attach the sample location to the inlet of the lung box with Tygon® tubing. Connect the vacuum pump to the outlet of the lung box with Tygon® tubing, ensuring that seals do not leak. Place the vacuum pump at least three feet downwind of the field sampling team. Ensure that the valve on the sample location is closed. Turn the vacuum pump on and check that there are no leaks in the sampling equipment. Place a 3L Tedlar® bag inside the lung box, connecting it to the Tygon® tube. Open the Tedlar® bag inlet valve. Close the lid of the lung box. Start the vacuum pump, open the ball valve and fill the Tedlar® bag. Close the ball valve on the sample location. Open the lung box and close the Tedlar® bag valve. Remove the Tedlar® bag from the lung box and close the lid. Record the readings on the project specific Process Equipment Data Sheet.

Collection into Summa Canister

The tubing shall be screened with a hand-held PID prior to sample collection. The tubing can be screened by attaching it directly to the PID. If the PID detects concentrations above background, a fresh length of tubing shall be cut and used for sample collection.

Remove the Summa canister and passive flow controller from the shipping box and record the canister identification number, time, and location in the project specific Field Logbook. Remove the Swagelock™ cap on the top of the Summa canister using a small, adjustable wrench. Remove the Swagelock™ cap and plug on the passive flow controller. Attach the passive flow controller to the canister. Attach the Tygon® tubing from the sample location to the flow controller. To start sampling, open the valve on the sample location. Open the canister at least one turn. The pressure will increase as the sample fills the canister.

Close the valve after the sample has been collected (vacuum will be approximately 5"Hg); do not over tighten the valve. Record the sampling time, initial and final pressure, and the sample canister identification number in the Field Logbook and on the chain of custody. The passive flow controller can be removed after the valve has been closed and the chain of custody recorded.

5 RESPONSIBILITIES

The Site Supervisor will conduct periodic inspections of the sampling procedures established by this SOP. The purpose of the inspection is to verify that the procedures and the requirements of the SOP are being followed. Any deviations or inadequacies that are identified during the inspection will be immediately corrected.

	HOT GROUNDWATER SAMPLING	Issued Date:	March 2011
		Revision:	2.3
		Approved:	John M. Bierschenk
			John M. Bierschenk, President

1 PURPOSE

To ensure that TerraTherm, Inc. (TerraTherm) follows a consistent program to collect groundwater samples. For the purpose of this SOP, groundwater may be at or above ambient conditions. As such, it is extremely important to follow established sampling methods including any health and safety protocols.

The preferred sampling method will be defined in the project specific work plan, sampling and analysis plan, and/or quality assurance project plan, but should be confirmed by the Project Manager prior to monitoring.

2 DISCUSSION

For the purpose of this Standard Operating Procedure (SOP), groundwater sampling may refer to the collection of water, whether extracted from the ground or processed through the treatment system. Data collected in the field is used to identify any potential safety hazards; as well as evaluate the efficiency and progress of the remediation effort; therefore, it is extremely important that these data be reliable and accurate.

3 APPLICATION

This SOP, although maybe not in its entirety, applies to most TerraTherm projects and the personnel responsible for groundwater collection.

4 PROCEDURES

Low-flow sampling and purging techniques are used in an effort to collect the most representative samples and to reduce the production of investigative-derived waste. Peristaltic and/or bladder pumps (depending on the sample intake depth) are used for purging and sampling. A dedicated ¼-inch Teflon™ sample tube is installed in each monitoring well for groundwater sampling. The tubing sample inlet is set in the well in the middle of the screen length. Each sample tube has a ¼-inch sample valve above the wellhead.

The following low-flow groundwater sampling procedure is adapted from the methods provided in the B&R Environmental, Technical Memo for Purging and Groundwater Sampling Using Low Flow Purging and Sampling Techniques (B&R Environmental, 1998). The apparatus used to perform sample cooling is shown in Figure 1 below.

Prior to initial sampling, a cooling coil is formed by wrapping a 10-ft length of ¼-inch stainless steel tubing around a 4-inch diameter pipe until six full turns have been made. The ends of the tubing are fashioned such that both

ends of the tubing extend upward. During sampling the tubing will be inspected, and any droplets formed on the exterior of the tubing will be wiped off before sampling.

- Connect ¼-inch sample tubing to the cooling coil and place the coil in a bucket or cooler with ice to form the ice bath.

- Connect the cooling coil and peristaltic/bladder pump to the Teflon tube in the well.

- Purge the well at an initial rate of ~1 liter per minute to minimize drawdown of the formation water. The well should be purged until field indicator parameters stabilize (for baseline samples) **OR** the minimum purge volume is removed.

  The minimum purge volume is two times the static saturated well volume. The equation to calculate the minimum purge volume is:

  $$V = 7.48\kappa r w^2(td-12)$$

  where V = one purge volume in gallons rw = radius of well casing in feet; td = total depth of well in feet; 12 = typical depth to groundwater in feet.

- The pumping rate is recorded on purge data sheets every 3 to 5 minutes during purging. Any adjustments made to the pumping rate during purging are recorded. Adjustments to the pumping rate are best made within the first 15 minutes of purging to minimize purging time.

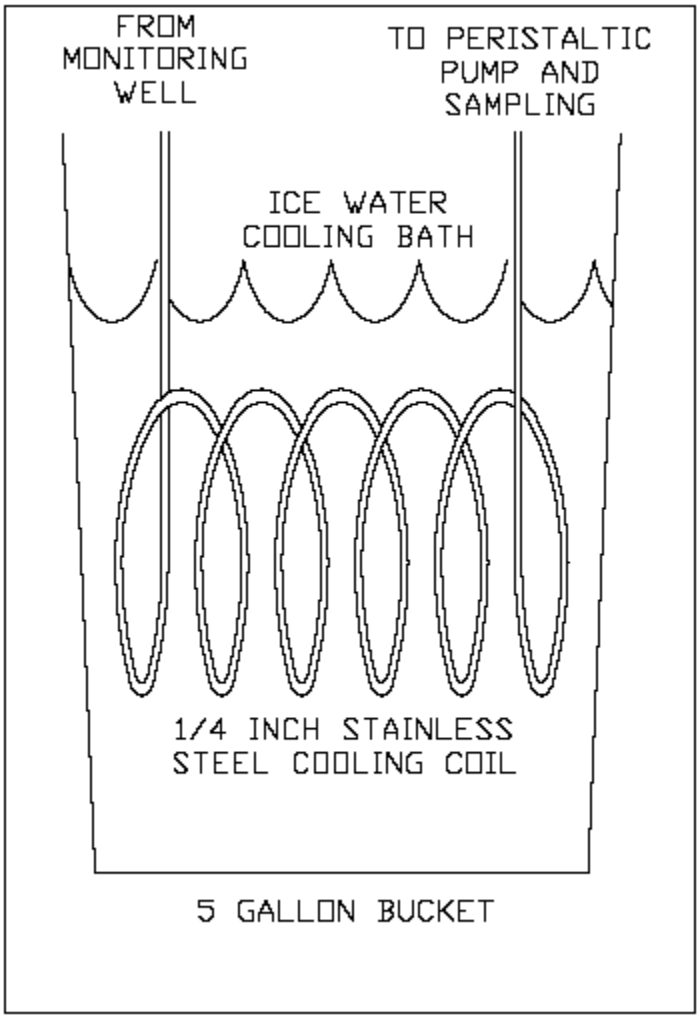
- <u>For baseline sampling events only:</u> At the initiation of well purging and during the purging effort, water quality parameters including specific conductance, pH and dissolved oxygen (DO) are measured with a multi-parameter meter with a flow through cell such as a YSI (or equivalent). Turbidity readings are obtained by collecting an aliquot of water through a "T" installed in the tubing and read using a turbidity meter (LaMotte 2020, or similar). Readings are recorded on the purge data sheets every 3 to 5 minutes. Field parameters are monitored until stabilization occurs. Stabilization is complete when three consecutive readings are within the following criteria: • Specific conductance and DO readings within 10 percent • pH within +/-0.2 standards units • turbidity at 10 NTUs or less 8.

- After the minimum purge volume is purged or all water quality parameters have stabilized, sampling may begin.

- For low yield wells, the well should be purged dry and allowed to recover. Sampling commences as soon as the well has recovered sufficiently to collect the appropriate volume for the anticipated sample analysis.

- Volatile organic compounds are collected first, followed by semivolatile, other organics, and finally inorganics utilizing the following method: a column of water is drawn in the cooling coil tubing with the pump; the well sample valve and the pump inlet valve are closed and the pump shut off; the cooling coil is disconnected from the well sample valve; the cooling coil is carefully removed from the ice bath; the pump inlet valve is opened; the sample is decanted into the sample vials from the pump end of the tubing via gravity flow. The process is repeated until the sample volume is collected.

Figure 1. Sample Cooling Apparatus



5 RESPONSIBILITIES

The Site Supervisor will conduct periodic inspections of the sampling procedures established by this SOP. The purpose of the inspection is to verify that the procedures and the requirements of the SOP are being followed. Any deviations or inadequacies that are identified during the inspection will be immediately corrected.

6 ATTACHMENTS

- Low Flow Purging Record

Low Flow Purging Record

Project:_____ Sample ID:_____

Purged by:_____ Sampled by:_____

Date Sampled:_____ Samples Collected:_____

Well ID:_____ _____

Casing Diameter:_____ _____

Depth to Groundwater:_____

Depth to Bottom:_____

Screen Length:_____

TIME (24 hr)	PUMP RATE (mL/min)	pH (SI unit)	SPEC. COND. (µS/cm°C)	DO (mg/L)	TURBIDITY (NTU)	Depth To Water (ft)

Notes:

_____

_____

_____

	HOT SOIL SAMPLING FOR CHLORINATED VOLATILE ORGANIC COMPOUNDS	Issued Date:	December 2009
		Revision:	1.0
		Approved:	John M. Bierschenk
			John M. Bierschenk, President

1 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to ensure that TerraTherm, Inc. (TerraTherm) follows a consistent program in performance of hot soil sampling, when such sampling is required. This SOP is specifically intended for sampling of soils to be submitted for chlorinated volatile organic compound analysis. Such soils are heated in excess of 100^{o}C and this SOP establishes a set of procedures to ensure collection of soil samples that are representative of field conditions and to minimize the potential for loss of volatile organic compounds during sample collection.

2 DISCUSSION

TerraTherm is typically responsible for overseeing or performing a soil sampling program for each major project. Sampling may be performed as progress sampling during In Situ Thermal Desorption (ISTD) operation or as confirmatory sampling at the conclusion of ISTD operation. This SOP outlines the methodology of such sampling, to help ensure consistency from one project to the next, and to ensure that sampling is performed in accordance with industry standard methods (Gaberell et al., 2002). It is recognized, however, that project specific goals may differ, and that sampling methodologies may change accordingly to some degree. It is the ultimate responsibility of the Project Manager to ensure that the plans meet both corporate and client requirements prior to their submittal.

3 APPLICATION

This SOP applies to all major TerraTherm projects, and to personnel responsible for performing or overseeing soil sampling activities. All work must be done in accordance with the project specific work plan, sampling and analysis plan, and/or quality assurance project plan procedures.

The procedures for performing hot soil sampling are as follows:

Sampling Tool

The length and diameter of the sampling tool may vary depending on the driller used to perform the work and the sampling tool selected. Soil samples will be collected using a core barrel type sampler equipped with four to eight 6-inch stainless steel sleeves. Figure 1 shows a 2 ft core barrel equipped with four 6-inch stainless steel sleeves.

Figure 1. Typical 2-foot Long Core Barrel.

Decontamination

All down-hole equipment (augers, core barrel, drive rods) must be decontaminated prior to use, between sampling locations, and at the end of each day. Sampling sleeves and end caps, which may be used more than once must be decontaminated prior to each use. Decontamination will consist of the following:

1) Removal of any gross contamination (e.g., wet soils stuck to the auger) by steam cleaning or other appropriate method;

2) Cleaning with a biodegradable soap (e.g., Alconox) and water solution using a scrub brush;

3) Rinsing off the soapy solution with clean water; and,

4) Rinsing with distilled water.

Sample Collection

There are two different methods described for sample collection below. The sample collection method shall be approved by the Project Manager to ensure that data results meet project goals.

Method 1

The decontaminated core barrel sampler and sample sleeve will be assembled and advanced to the desired depth. Once removed from the borehole, the core barrel will be disassembled, using temperature-rated gloves, and the sample sleeves will be removed sequentially, one-by-one. The ends of each sample sleeve (typically 6-

inches long) will be immediately covered with sections of Teflon tape and then capped with PVC end caps (Figure 2). One of the sleeves will be selected and a thermometer will be inserted through the end cap into the soil sample for temperature monitoring (Figure 2). The capped and sealed sleeves will then be placed into an ice bath for cooling. The ice bath will contain drain holes to allow melt water to freely drain rather than accumulate around the sample holder. A picture of an ice bath is included as Figure 3. The sample ID will be marked on each ice bath for reference when processing the cooled samples for labeling and shipping.

Figure 2. Removal and Capping of Sleeved Samples

Figure 3. Ice Bath for Cooling Samples

Once cooled to a temperature no higher than 50°F, the sample sleeve will be removed from the ice bath, labeled and sealed tightly in a plastic bag for shipment to the laboratory on ice in an insulated cooler. The laboratory will open and extrude five grams of soil from the middle of the sleeve and place in pre-cleaned, pre-preserved vials (deionized water and methanol).

The following information for each sample will be documented in a Field Logbook: brief soil description, depth interval of sample, temperature of sample collected at time of collection, time and date of sample collection, name of sampler/s. A photographic record of each sample collected, with identification label, is desirable. Figure 4 shows a typical setup for processing hot soil samples.

Figure 4. Typical Sample Processing Setup

Method 2

Alternatively, the cooled samples may be processed in the field by extruding five grams of soil from the middle of the sleeve and placing the extruded soil in pre-cleaned, pre-preserved vials (deionized water and methanol) provided by the laboratory. Vials will be properly labeled and stored on ice in an insulated cooler.

QA/QC Samples

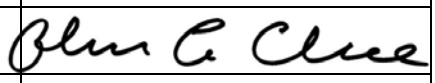
Trip blanks, equipment blanks, duplicates and any other Quality Assurance/Quality Control (QA/QC) samples will be collected in accordance with the project specific Quality Assurance Project Plan.

4 RESPONSIBILITIES

The Site Supervisor will conduct periodic inspections of the sampling procedures established by this SOP. The purpose of the inspection is to verify that the procedures and the requirements of the SOP are being followed. Any deviations or inadequacies that are identified during the inspection will be documented and immediately corrected.

5 REFERENCE

Gaberell, M., A. Gavaskar, E. Drescher, J. Sminchak, L. Cumming, W.-S. Yoon, and S. De Silva. 2002. "Soil Core Characterization Strategy at DNAPL Sites Subjected to Strong Thermal or Chemical Remediation." in: A.R. Gavaskar and A.S.C. Chen (Eds.), *Remediation of Chlorinated and Recalcitrant Compounds—2002. Proceedings of the Third International Conference on Remediation of Chlorinated and Recalcitrant Compounds* (Monterey, CA; May 2002). ISBN 1-57477-132-9. Battelle Press, Columbus, OH.

	Well Installation and Decommissioning Waste Stream Management	Issued Date:	July 2011
		Revision:	1.0
		Approved:	
			John LaChance, Vice President of Project Quality

1 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to ensure that TerraTherm, Inc. (TerraTherm) follows a consistent program when managing waste streams derived from drilling activities at the SRSNE Superfund Site. This SOP specifically discusses procedures for managing used Personal Protective Equipment (PPE), soil cuttings, liquids (such as purge water from drilling), and non aqueous phase liquid (NAPL) which may be encountered during well installation activities. It is important to follow these established waste stream management methods, including any related health and safety protocols as described in the site specific Health and Safety Plan (HASP), to the maximum extent feasible. It may be necessary to modify the methods described herein as field conditions become known.

2 DISCUSSION

Sonic drilling methods will be used to install the wells through the overburden soils and to core into bedrock, if encountered, to the specified bottom depth. The sonic method was chosen because it produces minimal soil cuttings. However minimal, soil cuttings will be produced and will be properly managed. In addition, during drilling activities, NAPL may be encountered. If NAPL is present, then the NAPL will be bailed or pumped out of the boring and will also be properly managed. Finally, during drilling activities, there is a possibility that water may be generated. This water will also be properly managed.

The potential hazards associated with these planned tasks have been evaluated in the site specific HASP and should be reviewed prior to conducting these field activities.

Prior to commencing any well installation activities, all personnel must be made aware of the designated waste storage area. The storage area should have an impervious floor, or a thick polypropylene sheeting layer covering the ground surface (at least 36 mm thick) with a berm around the storage area. The area should be located away from where there may be a potential for containers to be damaged due to equipment/vehicles. The area should be posted. The drums or containers containing the waste should be stored in rows with labels facing outward for identification purposes. For multiple rows of containers, a 2.5 foot minimum aisle space is required for access. The hazardous waste pending analysis labels shall be affixed to each container/drum identifying the contents of the drums and the date of collection.

Off-site disposal of waste material generated during well installation activities will be coordinated with the appropriate parties according to the properties of the waste material. The transportation to an approved disposal facility will be done by a licensed hauler in accordance with local, state and federal regulations.

For the purposes of waste disposal, the SRSNE Site Group will be considered the generator for any off-site waste shipments. *de maximis* will be responsible for signing all manifests as “agent for and on behalf of the SRSNE Site Group.”

3 APPLICATION

This SOP applies to for the well installation activities planned at the SRSNE site and specifically addresses the possibility of encountering NAPL during well installation activities.

4 PROCEDURES

The following table summarizes potential well installation related generated waste streams and the management approach for each:

Waste Stream Description	Management Approach
Used PPE	PPE will be removed in the Contamination Reduction Zone (CRZ), placed within plastic bags in accordance with the HASP, and labeled for proper characterization and disposal.
Soil Cuttings	Soil cuttings from well installation activities will be containerized and staged in the posted waste storage and containment area. If the soil cuttings are grossly impacted by NAPL, these soil cuttings will be separated from the "clean" cuttings, and placed in separate containers. The cuttings will be characterized and then properly disposed of off-site.
Decon Fluids	Accumulated wash water collected during equipment decontamination will be containerized for subsequent treatment using the existing on-site groundwater treatment system.
Groundwater	Groundwater generated during well installation activities will be containerized and transported to the HCTS. After allowing sediment to settle, the groundwater will be processed through the groundwater treatment system.
NAPL	NAPL will be containerized and temporarily stored on-site, pending characterization, then properly disposed of off-site.

5 DOCUMENTATION

- Field logbooks are maintained by the Site Supervisor to record daily activities. In the field logbooks, the waste management activities specific to this SOP should be recorded.
- As waste is generated, the Waste Accumulation Storage Area/Container Log must be filled out.
- The Waste Accumulation Storage Area/Container Inspection Log must be filled out and reviewed weekly, see attachment.
- Drums and containers must be appropriately labeled with the following information:
    - Site name and address;

  - Type of material;
  - Accumulation date;
  - Additional comments; and,
  - Site contact name and phone number.
- Drums and containers must also have a “Pending Analysis” label until the waste characterization results have been received.
- If the waste is to be transported across or onto public roadways, DOT-applicable labeling and shipping papers are required.

6 RESPONSIBILITIES

The Site Supervisor, or his designee, will conduct periodic inspections of the waste stream management procedures established by this SOP. The purpose of the inspection is to verify that the procedures and the requirements of this SOP are being followed. Any deviations or inadequacies that are identified during the inspection will be immediately corrected.

7 ATTACHMENTS

Waste Accumulation Storage Area/Container Log

Waste Accumulation Storage Area/Container Inspection Log

SRSNE Waste Accumulation Storage Area/Container Log

Date	Time	Container Number	Contents	Initials

SRSNE Waste Accumulation Storage Area/Container Inspection Log

Inspector's Name(s) (print)/initials _____/_____

Date	Time	Conditions (if other than satisfactory, complete next column)	Corrective Actions Taken	Inspector's Initials

Weekly inspections will be performed to assess container condition, complete and proper container labeling, that accumulation quantity or time limits have not been exceeded, materials are in secondary containment and are not leaking, incompatible wastes are segregated, containers are closed (except to add or remove waste). Note any discrepancies and corrective actions taken. Be sure to initial and date each entry.

	WATER QUALITY METER CALIBRATION (YSI MODEL)	Issued Date:	March 2011
		Revision:	1.1
		Approved:	John M. Bierschenk
			John M. Bierschenk, President

1 INTRODUCTION

This standard operating procedure (SOP) provides instructions for calibrating sondes that measure water quality parameters in groundwater and surface water sampling. This SOP is written specifically for the calibration of the YSI Model 6-Series Sonde (600XL). Water quality parameters include pH, temperature, conductivity/specific conductivity, oxidation-reduction potential (ORP), and dissolved oxygen.

This SOP complies with EPA protocols for the calibration of YSI model 6-series sondes (EPA, 2002).

2 HEALTH AND SAFETY

Consult specific Material Safety Data Sheets (MSDS) for the chemicals listed below for descriptions of hazards and first aid measures associated with each chemical.

Conductivity/Specific Conductivity

Calibration solutions for conductivity contain ***iodine*** and ***potassium chloride***. When using this standard, avoid inhalation, skin contact, eye contact or ingestion. If skin contact occurs, remove contaminated clothing immediately. Wash the affected area(s) thoroughly with large amounts of water. If inhalation, eye contact or ingestion occurs, remove to fresh air immediately and call 9-1-1.

pH

Calibration solutions for pH contain the following:

pH 4: ***potassium hydrogen phthalate, formaldehyde, water***

pH 7: ***sodium phosphate, potassium phosphate, water***

pH 10: ***potassium borate, potassium carbonate, potassium hydroxide, sodium ethylenediamine tetraacetate, water***

When using these standards, avoid inhalation, skin contact, eye contact or ingestion. If skin contact occurs, remove contaminated clothing immediately. Wash the affected area(s) thoroughly with large amounts of water. If

inhalation, eye contact or ingestion occurs, remove to fresh air immediately and call 9-1-1.

ORP

Zobell Solution, the most commonly used calibration standard for ORP, contains ***potassium chloride***, ***potassium ferricyanide***, and ***potassium ferrocyanide***. When using this standard, avoid inhalation, skin contact, eye contact or ingestion. If skin contact occurs, remove contaminated clothing immediately. Wash the affected area(s) thoroughly with large amounts of water. If inhalation, eye contact or ingestion occurs, remove to fresh air immediately and call 9-1-1.

Dissolved Oxygen

Sodium sulfite mixed with deionized water is used to check the dissolved oxygen performance of the sonde. When in the powder form, avoid inhalation or ingestion, especially if you are prone to asthma. If inhalation occurs, remove to fresh air. If ingestion occurs, induce vomiting immediately. If skin contact occurs, remove contaminated clothing immediately and wash for at least 15 minutes. If eye contact occurs, flush with plenty of water, lifting upper and lower eyelids for at least 15 minutes. Call 9-1-1.

3 EQUIPMENT AND MATERIALS

The items listed in the following equipment and materials list are required to calibrate the YSI accurately in accordance with this SOP. It should be noted that different solutions and/or additional solutions/equipment may be required depending on your field conditions and project requirements. Consult your project manager and/or quality assurance project plan (QAPP).

- YSI 600 XL Sonde with temperature, pH, conductivity, ORP, and dissolved oxygen probes
- YSI 650 Multiparameter Display System (MDS), or datalogger
- pH standards 4, 7, 10
- Conductivity standard (1413 µs/cm, or similar)
- ORP standard (Zobell 231 mV, or similar)
- Sodium sulfite
- DO membrane replacement kit
- Deionized (DI) or distilled water
- Small knife or scissors
- Q-tips
- Paper towels

- Calibration cups
- Write-in-the-Rain pen or similar
- Field book or calibration form

4 CALIBRATION PROCEDURES

Calibration of the YSI must be performed on each day of use prior to collecting any water quality parameters. Calibration checks should be done, at a *minimum*, at the end of each sampling day **and** when readings become erratic. Consult your project manager and/or QAPP for the required calibration frequency.

Prior to calibrating the Sonde, both the Sonde and calibration standards must stabilize with the atmospheric temperature for about 15 minutes. Failure to do so could result in incorrect water quality parameter readings.

If possible, pre-rinse the probe with a small amount of the solution you are going to calibrate with. This will eliminate potential cross contamination of solutions. Discard the rinsate after use.

Sonde Menu Setup

When first operating a Sonde, the report format on the MSDS should be set to display the correct parameters and the time and date should be verified and corrected if necessary.

Setting Calibration Parameters on the MDS

- At the main menu, highlight SONDE MENU, press ENTER
- Highlight REPORT, press ENTER
- Select the following parameters by pressing ENTER next to the parameters that are currently unselected. Set units to match those listed below. When complete, these parameters should appear as below. (Note: DO CHG and pH mV are only used during calibration and can be unselected for sampling. See Section 5.)
    - Date (optional)
    - Time (optional)
    - Temperature (C)
    - SpCond (µS/cm)
    - Cond (µS/cm)
    - DOsat (%)

- DO (mg/L)
- DO CHG
- pH
- pH mV
- ORP (mV)

- Press ESC to return to the REPORT menu

Setting the Date and Time (bottom of MDS)

- At the main menu, highlight SYSTEM SETUP, press ENTER
- Highlight DATE & TIME, press ENTER
- Select display format (m/d/y), press ENTER (black dot appears next to display format)
- Use the arrow keys to scroll down to DATE
- Enter date
- Arrow down to Time
- Enter time (military)
- Press ESC twice to return to the main menu

Setting the Date and Time (display as parameters)

- Highlight SONDE MENU, press ENTER
- Highlight STATUS, press ENTER
- Scroll down to date, type current date, press ENTER
- Scroll down to time, type current time, press ENTER
- Press ESC twice to return to main menu

Temperature

The temperature sensor should be calibrated at least once a year against a thermometer that is traceable by the National Institute of Standards and Technology (NIST). Verify with your rental company that this has been completed.

Dissolved Oxygen

Dissolved oxygen (DO) in water is measured using a membrane electrode. The DO membrane should be inspected daily for any signs of damage (tears, holes) or air bubbles trapped under the membrane surface. If damage or air bubbles are present, the membrane must be changed (see below for instructions). The electrode contacts (two small silver rectangles seen under the membrane) should also be inspected for any corrosion or discoloration. If either of these conditions exists, the electrode contacts should be cleaned (as described below).

Changing the DO Membrane

- Pull membrane and O-ring off the probe
- Rinse end of probe with DI water and dry with a Q-tip
- Clean the electrode contacts with a piece of fine sand paper (included in the membrane kit)
- Rinse the tip of the probe with KCl solution and place enough drops of KCl solution to cover the tip of the probe (included in the membrane kit)
- Stretch a new membrane over the tip of the probe being careful not to push **all** of the KCl solution out (some will leak out)
- Starting with the side of the probe closest to you, roll the O-ring over the tip to secure the membrane
- Inspect the new membrane to ensure NO air bubbles or wrinkles are present
- Trim excess membrane away using small scissors or knife

Dissolved Oxygen

- Put probe, with probe guard on, in storage container with moist sponge OR place storage container cap with 1/8 inch of water on Sonde loosely (twist one or two threads)
- At the main menu, highlight SONDE MENU, press ENTER
- Highlight CALIBRATE, press ENTER
- Highlight DISSOLVED OXY, press ENTER
- Highlight DO %, press ENTER (the barometric pressure should be displayed)
- Verify this pressure against the pressure displayed in the lower right hand corner of the display
- If pressures differ, enter the value shown in right hand corner, press ENTER. If not, press ENTER
- Once DO% is stable (allow at least 10 minutes), write down the value on the METER CALIBRATION REPORT

- Press ENTER
- Press ENTER to return to DO calibration menu
- Press ESC to return to the CALIBRATE menu

Conductivity/Specific Conductivity

Electrical conductivity is a measure of water's capacity to conduct electricity, and therefore a measure of the water's ionic activity and content. It is measured by placing two plates in the sample and applying a potential across the plates. There is a direct correlation between the concentration in water of dissolved ionic constituents and the electrical conductivity of the water. The conductivity of water changes substantially as its temperature changes; specific conductivity is conductivity normalized to a temperature of 25°C.

- Highlight CONDUCTIVITY, press ENTER
- Highlight SpCond, press ENTER
- Completely submerge probe in standard
- Enter value of standard (pay close attention to units), press ENTER
- Verify that the value of DO CHG is between 25 – 75. If it is not in this range, change the DO membrane.
- Check SpCond and Cond readings. If a drastic spike is seen every four seconds, change the DO membrane. If readings are not within ±10% of the standard, use a new standard.
- Once the SpCond and Cond readings have stabilized, write them down on the meter calibration report and count to 10.
- Press ENTER; the SpCond and Cond reading will calibrate.
- Press ENTER to return to the conductivity calibration menu screen.
- Press ESC to return to the main menu.
- Rinse probe with DI water and dry with paper towel.

To check (from RUN menu):

- From run menu, submerge probe in the solution again. If the displayed value is not within ±10% of the standard value, repeat calibration procedures.

pH

The pH of a sample is determined electrometrically using a glass electrode (small glass bulb). Calibrate with pH

standards that will span the expected pH values of the groundwater (typically 4, 7 and 10).

- Highlight ISE1 pH, press ENTER.
- Highlight 3-POINT, press ENTER.
- Always start with pH 7 standard.
- Completely submerge probe in pH 7 standard.
- Enter 7.0 at “enter value” prompt, press ENTER.
- Verify pH mV readings are within specifications listed below. If not, call rental company for technical assistance.

  pH 7.0 = ±40 mV

  pH 4.0 = (180 mV – pH 7.0 value) should be ±170 mV

  pH 10.0 = (180 mV – pH 7.0 value) should be ±170 mV

- Once readings have become stable, write down the value on the meter calibration report, count to 10, and press ENTER.
- Press ENTER again to proceed to next pH value.
- Rinse probe with DI water and dry with paper towel.
- Continue for pH 4 and pH 10, being sure to clean and dry the probes in between each solution.
- Press ENTER to return to pH CALIBRATION menu.
- Press ESC to return to the CALIBRATION menu.
- Rinse probe with DI water and dry with paper towel.

To check (from RUN menu):

- From run menu, submerge probe into the pH 7 solution again. If the reading is not accurate to within ±0.05 units, repeat the calibration procedures.

Oxidation Reduction Potential (ORP)

ORP or Redox Potential is related to the concentration of oxidizers or reducers in a solution, and their activity or strength. The ORP value (in mV) of the solution quantifies the true ability or potential that the solution has to oxidize or reduce.

You need to know the temperature of the solution to calibrate the probe for ORP.

- At main menu, highlight SONDE RUN.
- Submerge probe (or pH/ORP probes) in ORP standard.
- After the temperature of the solution has stabilized, write it down on the meter calibration report.
- Press ESC to return to the main menu.
- Highlight SONDE MENU, press ENTER.
- Highlight CALIBRATE, press ENTER.
- Highlight ISE2ORP, press ENTER.
- Enter value corresponding to the temperature of solution (refer to Calibration Temperature Correction Chart) at ENTER VALUE prompt, press ENTER.
- Once stable, write ORP value on meter calibration form.
- Press ENTER to calibrate.
- Press ENTER to return to calibration menu.
- Press ESC to return to the main menu.
- Rinse probe with DI water and dry with paper towel.

Dissolved Oxygen Check

This function should only be used as a check. Never calibrate this value. This can be performed from either the RUN or CALIBRATE menu.

- Submerge the probe in a saturated sodium sulfite solution (25 grams sodium sulfite to 1000 mL DI water)
- Verify that the probe reads <0.5 mg/L. If not:
    1. mix a new solution
    2. change the DO membrane.
- Rinse probe with DI water and dry with paper towel.

5 FIELD MEASUREMENTS

Setting Field (Report) Parameters in the MDS

- Highlight Sonde menu, press ENTER
- Highlight REPORT, press ENTER
- Unselect the following parameters (if selected) by pressing ENTER next to the ones that are currently selected (black dots).
    - ⊙ DO CHG
    - ⊙ pH mV
- When you are finished, the following parameters should be displayed.
    - ⊙ Date (optional)
    - ⊙ Time (optional)
    - ⊙ Temperature (C)
    - ⊙ SpCond (µS/cm)
    - ⊙ Cond (µS/cm)
    - ⊙ DOsat (%)
    - ⊙ DO (mg/L)
    - ⊙ pH
    - ⊙ ORP (mV)

Datalogging

- From Sonde Main Menu, highlight SONDE RUN, press ENTER
- Highlight START LOGGING, press ENTER
- Use right arrow key to select CONFIGURE, press ENTER
- Type in your recording interval (e.g., 00:00:10)
- Arrow down to highlight EDIT SITE LIST, press ENTER
- Press ENTER to add monitoring well ID
- Press ENTER to populate entry

- Press ESC three times to return to the RUN menu
- Verify START LOGGING is highlighted, press ENTER
- Select well you just added, press ENTER
- Once well is stable, press ENTER to STOP LOGGING
- Repeat steps above for each new monitoring well

Uploading Data to PC

- Load EcoWatch software on your computer (included with YSI)
- Connect MDS to hard drive using cable included
- At Main Menu, highlight FILE, press ENTER
- Highlight UPLOAD to PC, press ENTER
- Highlight file(s) to upload, press ENTER
- Select file type (e.g., binary, comma & " " delimited, ASCII text)
- Launch program
- Select the Sonde icon
- Select the COMM 1, OK
- Press ENTER on handset to send file to PC

View Uploaded Files on PC

- Close COM 1 dialog box
- Select Real-Time, open
- Select all file types
- Select file, OK
- View as table, graph, or both

6 CALIBRATION CHECKS

As with any instrument, Sondes have a tendency to "drift" which may cause them to operate outside the acceptable quality control ranges. The calibration should be checked at a minimum at the end of each sampling

day. These checks should be documented on the calibration form.

Calibration checks are done from the run menu. The Sonde is placed into each of the calibration standards. Verify that the values displayed are within the acceptable range of each calibration standard. If values are outside of the range, recalibrate.

7 TROUBLESHOOTING

In some instances, it may be necessary to "uncalibrate" a parameter to return to factory settings. This should not be done unless instructed by technical support.

- Access the desired parameter to uncalibrate in the calibrate menu
- Hold the ENTER and ESC keys down
- Highlight YES, press ENTER

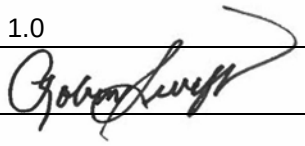
8 REFERENCES

US EPA, Standard Operating Procedure for Calibration and Field Measurement Procedures for the YSI Model 6-Series Sondes, Revision 1, 05/31/02.

US Environmental, YSI Field Calibration Guide.

YSI, 2001, 650 MDS Operation Manual.

YSI, 2001, YSI Environmental Monitoring Systems Operational Manual (6-Series).

	WELL DECOMISSIONING AT THE SRSNE SUPERFUND SITE	Issued Date:	July 2011
		Revision:	1.0
		Approved:	
			Robin Swift, Engineer

1 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to ensure that TerraTherm, Inc. (TerraTherm) follows a consistent program to decommission groundwater monitoring wells, heater cans, vapor extraction wells, temperature monitoring points and pressure monitoring points within the thermal wellfield at the SRSNE Superfund Site. Specifically, this SOP presents the procedures to be used for effective permanent abandonment of these wells utilizing cement/bentonite grout. It may be necessary to modify the methods described herein as field conditions become known.

2 DISCUSSION

Well abandonment is conducted to prevent the well from becoming a conduit for migration of contaminants from the ground surface to the water table or between aquifers. The preferred method of abandonment is to completely remove the well casing and screen (if applicable) from the borehole; however, certain situations may warrant grouting the well in place.

Potential hazards associated with well decommissioning are thoroughly evaluated prior to conducting the field activities. The site specific Health and Safety Plan (HASP) provides a description of potential hazards and associated safety and control measures. Well abandonment equipment will be decontaminated in accordance with the Decontamination of Equipment SOP prior to use. Although well abandonment is typically conducted from least to most impacted, field logistics may necessitate an adjustment to this order. The following devices are generally used for well abandonments:

- All terrain extended boom forklift
- Bentonite-cement grout
- Tremie tube or suitable pressurized placement method

3 APPLICATION

This SOP applies to the well decommissioning activities planned at the SRSNE site.

4 WELL DECOMISSIONING PROCEDURES

The following section describes the procedures for well decommissioning. Any variation in these procedures must be approved by the Project Manager and Engineer and must be fully documented. Field work cannot progress until deviations are approved or resolved.

4.1 Removal of Wells

When possible, thermal wells and monitoring points will be pulled out using a forklift. The remaining open portion of the borehole will be backfilled with a bentonite-cement grout installed using a tremie tube or other suitable pressurized placement method. Once the grout sets, a minimum 2,000 psi concrete plug will be installed from the top of the grout to the ground surface.

Groundwater monitoring wells will be overdrilled and the casing and sand pack will be removed and containerized. The remaining open portion of the borehole will be backfilled with a bentonite-cement grout installed using a tremie tube or other suitable pressurized placement method. Once the grout sets, a minimum 2,000 psi concrete plug will be installed from the top of the grout to the ground surface.

4.2 Grouting Method and Materials

In the event that a well or portion of a well cannot be removed from the ground, the casing will be cut off at a depth of approximately 2 feet below ground surface. The remaining portion of the casing will be backfilled as described in the previous section.

5 DOCUMENTATION

The Site Supervisor, or his designee, will document the decommissioning of the wells in their log book. The information required includes:

- Start and finish time(s)
- Removal of well
- Well casing cut at a depth of 2 ft bgs
- Amount of grout used
- Note any deviations from the SOP and/or any characteristics specific to that well

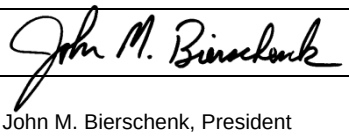
A licensed Connecticut driller will complete well abandonment logs for the Groundwater Monitoring Wells.

6 DECONTAMINATION AND WASTE MANAGEMENT

Well abandonment procedures typically results in the generation of solid waste material (such as well materials). The generated waste material will be staged onsite for proper disposal according to TerraTherm's Well Installation and Decommissioning Waste Management SOP. Equipment decontamination will be performed in a manner consistent with the Decontamination of Equipment SOP.

7 RESPONSIBILITIES

The Site Supervisor, or his designee, will conduct periodic inspections of the decommissioning procedures established by this SOP. The purpose of the inspection is to verify that the procedures and the requirements of the SOP are being followed. Any deviations or inadequacies that are identified during the inspection will be immediately corrected.

	MONITORING WELL DEVELOPMENT WITH POSSIBLE NAPL AT THE SRSNE SUPERFUND SITE	Issued Date:	February 2011
		Revision:	1.0
		Approved:	
			John M. Bierschenk, President

1 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to ensure that TerraTherm, Inc. (TerraTherm) follows a consistent program during the development of monitoring wells at the SRSNE Superfund Site. This SOP specifically discusses procedures for development of monitoring wells where NAPL may be encountered during well development. It is extremely important to follow these established procedures including any health and safety protocols described in the site specific health and safety plan.

2 DISCUSSION

This SOP, although maybe not in its entirety, applies to most TerraTherm projects and the personnel responsible for monitoring well development. It specifically addresses the possibility of encountering NAPL during well development.

3 APPLICATION

The objectives of monitoring well development are to remove fine grained sediments (fines) that may have accumulated in the well and/or the filter pack around the well during well installation, and to enhance the hydraulic connection between the target zone and the well.

4 EQUIPMENT

The following equipment shall be used during well development.

- Photoionization detector (PID);
- Interface probe;
- Submersible pump, peristaltic pump, and/or bailer (depending on depth of groundwater);
- Surge block;
- Container (drums or fractionation tank) for purged water and NAPL;
- Container with known volume (e.g., 5-gallon bucket) for flow estimation;
- Water level indicator;
- Stopwatch or timer;
- Clear glass jars (at least two);
- Well development record;
- Field notebook; and
- Pens.

5 PROCEDURES

Monitoring well development shall be performed as soon as practical, after well installation, but not sooner than 48 hours following placement of the grout seal. Weather conditions may increase grout set time and, consequently, further delay development.

Several activities must take place prior to well development. First, open the monitoring well and take initial measurements. These measurements will include:

- Head space air monitoring reading, conducted with a hand-held PID.
- Water level, total depth of the well, and a determination if NAPL is present conducted with an interface probe. If present, the location of the NAPL (on top of the water or at the bottom of the well) and thickness will be measured and recorded.

These initial measurements will be recorded on the well development log sheet attached.

Prior to development, an attempt will be made to remove any NAPL detected in a well. The NAPL will be bailed or pumped out and placed in a secure container. Following each removal event, measurements will be periodically made over a minimum of 4 hours to determine if additional NAPL accumulates in the well. If additional NAPL does accumulate in the well, it will be removed. These steps will continue until NAPL does not accumulate in the well over the 4 hour period. Once this condition has been met, development of the well can proceed.

If NAPL continues to accumulate in the well, TerraTherm's project manager and project engineer will discuss NAPL removal and development options with the oversight/project manager for de maximus,Development of the wells shall be accomplished using both a pump (e.g., submersible or peristaltic) and a surge block equipped with an inertial valve. Pumps used for well development shall be periodically raised and allowed to drain back into the hole in order to induce flow out through the well screen.

The surge block is used to flush the filter pack of fine sediment in instances where field personnel expect that development may be improved by surging. Surging will be conducted slowly to reduce disruption to the filter pack and screen and to establish bridging to minimize the transport of fines from the formation, through the filter pack, and into the well. Following surging, the well will be pumped to remove water and sediment drawn in by the surging process until suspended sediment is reduced to acceptable levels (see below). Alternating use of the surge block and pump should be followed until well development criteria are met.

The following criteria shall be monitored during well development:

- Total volume purged ;
- Visual observations of purged water (turbidity and NAPL); and
- .Presence of NAPL in the well (if NAPL is observed in the well, the procedures outlined above will be followed until NAPL does not accumulate in the well over a 4 hour period and development will continue).

A well shall be considered fully developed when all the following criteria are met:

- A minimum of three well volumes have been removed; and
- The well water is clear to the unaided eye (based on observations of water clarity through a clear glass jar).

These criteria may be modified with approval by the Project Manager and/or Project Engineer. Any deviations from the above approach or criteria will be noted on the well development log.

6 DECONTAMINATION

The cap and all internal components of the well casing above the water table shall be rinsed with deionized water to remove all traces of soil, sediment, and cuttings. This washing shall be conducted before and/or during development.

Pumping and surge block equipment used to develop the wells shall be decontaminated prior to and after use. Development fluids shall be placed into a sealable container (drum or fractionation tank) for transport to treatment plant for treatment and discharge.

7 DOCUMENTATION

During well development, a log shall be kept of the activities. A copy of the log is attached to the end of this SOP. The information required includes:

- Start and finish time
- Depth of well installation/depth to bedrock
- Measureable NAPL detected?
- Location of NAPL (if applicable)
- Note of any abnormalities

8 RESPONSIBILITIES

The Site Supervisor shall conduct periodic inspections of the well development procedures established by this SOP. The purpose of the inspection is to verify that the procedures and the requirements of the SOP are being followed. Any deviations or inadequacies that are identified during the inspection will be immediately corrected.

9 ATTACHMENTS

Example of Well Development Log

TERRATHERM

WELL DEVELOPMENT LOG[1]

WELL ID:_____ **DATE:**_____

DEVELOPED BY:_____ **SITE:**_____

Step 1:

MEASUREMENTS

PID readings:_____

DEPTH TO PRODUCT:_____ TOTAL PRODUCT:_____ REMOVED VIA:_____

DEPTH TO WATER (ft): _____ DEPTH TO BOTTOM (ft):_____WELL DIAMETER (in):_____

HEIGHT OF WATER COLUMN (ft): (DEPTH TO BOTTOM-DEPTH TO WATER) _____

HEIGHT OF STICK-UP:_____

Step 2:

PUMP W/ SURGE BLOCK

*START TIME:*_____ *STOP TIME:*_____

*RECHARGE TIME:*_____

*TOTAL GALLONS PUMPED:*_____

Step 3:

PUMP W/ GRUNDFOS

START TIME:_____ STOP TIME:_____

DID THE WELL PURGE DRY? _____

START TIME: _____ STOP TIME:_____

GALLONS PUMPED:_____

RECHARGE TIME: _____

TOTAL GALLONS PUMPED:_____

END TIME:_____

NOTES:_____
_____
_____

[1] Well development shall occur as soon as practical, but no sooner than 48 hours after well installation.

	WELL INSTALLATIONS, WITH POSSIBLE NAPL, AT THE SRSNE SUPERFUND SITE	Issued Date:	April 2013
		Revision:	5.3
		Approved:	John M. Bierschenk
			John M. Bierschenk, President

PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to ensure that TerraTherm, Inc. (TerraTherm) follows a consistent program to install groundwater monitoring wells (MW), heater cans (HO), vapor extraction wells (VEW), temperature monitoring points (TMP) and pressure monitoring points (PMP) within the thermal wellfield at the SRSNE Superfund Site. This SOP specifically discusses procedures for installation of wells at the SRSNE Superfund Site where NAPL may be encountered during well installations. It is important to follow these established drilling methods including any health and safety protocols described in the site-specific Health and Safety Plan to the maximum extent feasible. It may be necessary to modify the methods described herein as field conditions become known.

The well installation procedures and designs described herein have been carefully developed to minimize the potential for NAPL to vertically migrate into bedrock during installation and construction of the heater cans and monitoring points associated with the in-situ thermal remediation system to the extent practicable.

DISCUSSION

The sonic drilling method will be used to install drill casing through the overburden soils and to core into bedrock, when encountered, for heater wells and temperature monitoring points. The specified bottom depths were selected based on available information of depth to bedrock across the site and the design objective of heating several feet into bedrock in order to ensure adequate heating of the bottom of the overburden soils throughout the NAPL treatment area.

Sonic drilling methods will also be used to install drill casing to the desired depths in the overburden soils to allow installation of the vapor extraction wells, groundwater monitoring wells, pressure monitoring points, and temperature monitoring points. Sonic drilling can be used to penetrate concrete (up to 8" thick) that may exist in the thermal well field beneath the ground surface.

- Sonic drilling provides significant protection against unintended NAPL migration during drilling and well installation due to the following:

- The sonic method results in a tight seal between the outside of the drill casing and the borehole wall. The sonic method has flexibility in advancing two concentric, smooth-walled casings. It is expected that the outer drill casing will be advanced only to the top-of-rock surface to isolate the overburden while the inner casing drills the required socket in the top of rock to facilitate heater-well installation into the upper portion of the bedrock.

- Once the outer drill casing is seated into the top of the bedrock, the inside of the drill casing may be checked for the presence of NAPL before the inner core barrel is advanced into bedrock. If NAPL is present, it will be removed by *de maximis*/ARCADIS prior to advancing the inner core barrel.

- High temperature grout may be added, if necessary, to the drill casing prior to advancing the casing into bedrock to help seal off the overburden from the bedrock.

- Following installation of the heater can and/or temperature monitoring point at the bottom of the borehole, the annular space between the heater can and the borehole wall will be tremie pumped with high-temperature grout as the outer drill casing is removed.

- Following installation of the groundwater monitoring well, vapor extraction well, and pressure monitoring point to the bottom of the borehole, the annular space between the well and the borehole wall will be filled with sand pack and high-temperature grout, as per the design specifications, while the outer casing is removed.

- The sonic method results in minimal production of cuttings. Cuttings can be efficiently and safely handled since they are removed from the subsurface in a core barrel and directly deposited into a secure location (i.e., drum and/or soil bin), thereby minimizing handling, potential odors, and the volatilization of contaminants. The cuttings that show significant visible NAPL (not just small, isolated, disconnected "residual" NAPL blobs, but significant NAPL "pools") will be placed into a separate secure location from the non-saturated cuttings.

During the drilling activities, the air in the breathing zone will be monitored as per TerraTherm's Air Monitoring SOP-001-01.

APPLICATION

This SOP, although maybe not in its entirety, applies to most TerraTherm projects and the personnel responsible for well installation. It specifically addresses the possibility of encountering NAPL during well installations that extend into bedrock.

WELL INSTALLATION PROCEDURES

A standard 4 x 6 sonic drilling system is used to advance the borehole and install the heater cans, temperature monitoring points, or monitoring wells. The 4 x 6 system consists of a 4" core barrel (4.5" OD, 3.75" ID) and a 6" outer casing (5.5" OD, 4.75 ID). The core barrel fits snugly within the outer casing with approximately ~1/8" of clearance between the outside of the core barrel and the inside wall of the casing. Both the core barrel and outer casing are equipped with cutting shoes.

GROUNDWATER MONITORING WELL INSTALLATION: The following summarizes the approach for installing the monitoring wells at the SRSNE Superfund Site. Each groundwater monitoring well installed within the thermal treatment area will be drilled to the depth of the top of weathered bedrock, as determined based on soil sampling and logging at an adjacent heater-can location located within 5 feet of the monitoring well borehole. Each monitoring well will have a 2-ft long grouted sump at the bottom. Additional installation details and construction materials can be found in the Site drawing package.

- The 6" outer casing will core out the first 5 ft. of the hole. The outer casing is then retracted and emptied into a container at the surface.
- Once the outer casing is placed back into the hole, the inner 4" core barrel will be advanced down to the estimated depth of the top of rock, or until the driller interprets that bedrock has been encountered, if shallower.

Once the inner core barrel is advanced to the top of weathered rock as identified in the adjacent heater-can location, the outer casing will be advanced to the matching depth of the inner core barrel, and the inner core will then be extracted.

- High temperature grout will be injected by the tremie method into the borehole to fill approximately the bottom 2 feet of the borehole.
- Before the grout sets, the well materials will be quickly installed to the bottom of the borehole, with the sump surrounded by grout. A grout basket (optional) may be included at the base of the well screen, to help restrict grout from entering the screen prior to the grout curing.
- Once the monitoring well installation is at the designed depth, the filter pack is added and the drill casing is extracted with sonic vibration to help compact and settle the sand filter pack around the well.
- Once the screen has been backfilled to the designed depth, a high temperature grout will be tremie pumped to the surface.
- The bottom of the well casing will be immediately inspected for grout inside of the well using a bottom loading bailer.
    - If grout has entered the well, water will be added to flush the well and pump out excess grout.
- It is expected that the grout will settle. After settling grout will be added to top of the hole.
- After drilling operations, all equipment will be decontaminated as per the Decontamination Standard Procedure.

VAPOR EXTRACTION INSTALLATION: The following summarizes the approach for installing the vapor extraction wells at the SRSNE Superfund Site. Vapor extraction wells are shallow, installed to a depth of approximately 8 ft. bgs. They consist of 2" diameter, Schedule 80 carbon steel riser with 0.010-slot stainless steel screen. Additional installation details and construction materials can be found in the Site drawing package.

- The 6" outer casing will core out the first 5 ft. of the hole. The outer casing is retracted and emptied into a container at the surface.
- Once the outer drill casing is placed back into the hole, the inner 4" core barrel will be advanced to the installation depth (varies within treatment area).
- Once the inner core barrel reaches installation depth, the outer casing will then be advanced to the installation depth and the core barrel will be extracted.
- After the core has been extracted, the core barrel will be advanced in approximately 5-10 foot increments followed by the drill casing until installation depth is reached.
- The well material will be installed at the base of the borehole.
- Once the well is installed at depth, the filter pack is installed and the drill casing is extracted with sonic vibration to help compact and settle the sand filter pack around the well screen.
- Once the screen filter pack has been added to the designed depth, high temperature grout will then be added to surface.
- It is expected that the grout will settle. After settling, grout will be added to top off the hole.
- After drilling operations, all equipment will be decontaminated as per the Decontamination Standard Procedure.

TEMPERATURE MONITORING POINT (TMP) INSTALLATION: The following summarizes the approach for installing the temperature monitoring points at the SRSNE Superfund Site. Temperature monitoring points are installed to bedrock (i.e., depth will vary within well field). They consist of 1 ½" diameter, Schedule 40, carbon steel pipe. Additional installation details and construction materials can be found in the Site drawing package.

- The 6" outer casing will core out the first 5 ft. of the hole. The outer casing is retracted and emptied into a container at the surface.
- Once the outer drill casing is placed back into the hole, the inner 4" core barrel will be advanced to the installation depth (varies within treatment area).
- Once the inner core barrel reaches installation depth, the outer casing will then be advanced to the installation depth and the core barrel will be extracted.
- After the core has been extracted, the core barrel will be advanced in approximately 5-10 foot increments followed by the drill casing until installation depth is reached.

- The monitoring point material will be installed at the base of the borehole.
- Once the material is installed to depth, high temperature grout will then be tremie pumped to surface.
- It is expected that the grout will settle and be evident near the surface. After settling, grout will be added to top off the hole.

PRESSURE MONITORING POINT (PMP) INSTALLATION: The following summarizes the approach for installing the pressure monitoring points (PMP) at the SRSNE Superfund Site. PMPs are installed to a depth of approximately 7 or 12 ft. bgs, depending on their location within the wellfield. They consist of 2" diameter Schedule 40 carbon steel riser with 0.010-slot stainless steel screen. Additional installation details and construction materials can be found in the Site drawing package.

- The 6" outer casing will core out the first 5 ft. of the hole. The outer casing is retracted and emptied into a container at the surface.
- Once the outer drill casing is placed back into the hole, the inner 4" core barrel will be advanced to the installation depth (varies within treatment area).
- Once the inner core barrel reaches installation depth, the outer casing will then be advanced to the installation depth and the core barrel will be extracted.
- After the core has been extracted, the core barrel will be advanced in approximately 5-10 foot increments followed by the drill casing until installation depth is reached.
- The monitoring well material will be installed at the base of the borehole.
- Once the material is installed to depth, the filter pack is installed and the drill casing is extracted with sonic vibration to help compact and settle the sand filter pack around the well screen.
- Once the screen has been backfilled to the designed depth, high temperature grout will then be tremie pumped to surface.
- It is expected that the grout will settle and be evident near the surface. After settling, grout will be added to top off the hole.

HEATER ONLY (HO) INSTALLATION: The following summarizes the approach for installing the heater cans at the SRSNE Superfund Site. Materials of construction and installation details can be found in the Site drawing package.

- The 6" outer drill casing will core out the first 5 ft. of the hole. The outer casing is retracted and emptied into a container at the surface.
- Once the outer drill casing is placed back into the hole, the inner 4" core barrel will be advanced to the expected depth to bedrock, or until the driller interprets that bedrock has been encountered, if shallower.
- The outer casing will then be advanced to the same depth, and the core barrel will be extracted.
- The contents of the core barrel from shallow soil intervals (more than 5 feet above of the estimated bedrock depth) will be emptied into a bobcat bucket or similar, visually assessed and segregated based on NAPL presence (if any), and transported to the appropriate waste staging area(s). The soil samples obtained within 5 feet of the expected bedrock depth will be extracted, collected, and placed in bags, if possible, for logging and inspection. If the soil samples are too hot to place in bags, they will be placed in order on a suitable surface or container to allow them to cool for logging and inspection. The samples will be placed in a linear sequence such that the locations of the top and bottom of each "run" are known, and they will be labeled accordingly.
- The interpretation of when the core barrel reaches the top of the weathered bedrock will be made by ARCADIS.
- If the borehole has reached the expected bedrock depth, but bedrock has not yet been encountered, the core barrel will be advanced in increments of up to 5 feet and the core samples will be inspected for the presence of visible NAPL and the presence of weathered bedrock, if any. If the top of bedrock was not observed in the core sample, then the outer casing will be advanced to the same depth as the core barrel. This process will be repeated until the top of rock is encountered and confirmed by ARCADIS. The drill casing will then be advanced and "keyed" into the top of bedrock. Test drilling performed at the site indicated that this will most likely provide a tight seal with the rock surface. (Note: A tight seal was noted on all three test holes performed at the site.)

- ARCADIS and/or *de maximis* will inspect the sample materials obtained from the bottom portion of the overburden (within approximately 3 to 5 ft. of the top of weathered bedrock) for the presence of visible NAPL.
- NAPL will be interpreted as present if observed with the unaided eye.
    - If NAPL is observed in the sample, ARCADIS and/or *de maximis* will check the bottom of the borehole for the presence of NAPL and remove the NAPL, if present, using a peristaltic pump with a check valve (preferred) or bottom-loading bailer. The NAPL will be placed into a sealable container (e.g. 55 gallon drum).
    - After removing the NAPL (if any) from the bottom of the borehole, high temperature grout will be injected into the bottom of the borehole.

- If NAPL is not observed in the sample, the driller will check the bottom of the borehole for the presence of water using a water-level indicator.
    - If the borehole is dry, drilling will proceed as described below.
- After the above actions have taken place, the core barrel will be advanced into bedrock to the desired depth. Typically only one core run will be required to reach the target depth, but depending on the amount of rock coring required for the boring this may be accomplished in several steps. After each bedrock core run, the contents of the core barrel(s) will be extracted and collected for logging and inspection by others.

IF BEDROCK IS NOT ENCOUNTERED: If the design depth of the heater has been achieved but bedrock has not, the following will take place.

- The core barrel will be advanced in increments of up to 5 feet and the core samples will be inspected for the presence of visible NAPL and the presence of weathered bedrock, if any.
- Log designed depth and actual depth on the heater can construction log.
- Either use longer heater can or weld extension onto heater can.

- Once the final core has been extracted, ARCADIS and/or *de maximis* will check the bottom of the borehole for the presence of NAPL and remove the NAPL, if present, using a peristaltic pump with a check valve (preferred) or bottom-loading bailer. The NAPL will be placed into a sealable container (e.g. 55 gallon drum).
- After removing the NAPL (if any) from the bottom of the borehole, high temperature grout will be injected into the bottom of the borehole via tremie pipe and the heater can will then be installed.
    - Once the heater can is installed, the high temperature grout will be topped off in the annulus between the heater can and the borehole wall.
- It is expected that the grout will settle and be evident at the surface. Grout will be added to top off the hole as needed.
- After drilling operations, all equipment will be decontaminated as per the Decontamination Standard Procedure.

HEATER ONLY HANDLING: Heater cans consist of 3" diameter Schedule 80 carbon steel at 18, 21, 27, & 31 ft. lengths and weigh between 180-270 lbs., depending on their length. Because of their weight, these cans require additional care during installation to ensure the safety of the workers installing them as well as the safety of others onsite. The preferred method for handling the heater cans is presented below; however, individual locations may dictate variances in the installation method.

- Personnel not required for Heater Can installation will stand clear of the area and remain outside the footprint consistent with the length of the Heater Can (i.e. stand at least 35' away for a 30' Heater Can).
- A strap will be installed around the bottom of the can in a double choker configuration and attached to the winch located at the top of the drill rig mast. The winch will pick up the bottom of the can and it will be guided into place in the rod handler.
- Once the rod handler clamps the can, the sling will be relocated around the top of the can and re-attached to the winch.

- The rod handler will then lift the can up in the air as the slack on the winch line is taken in. When the can is above the hole, the rod handler will release the can and the can will be lowered into the hole slowly with the winch.

If site conditions don't allow for the can to be handled with the rod handler, the can will be installed by lifting the can with the winch on the rig or a fork lift.

DOCUMENTATION

The Site Supervisor, or his designee, will document the installation of the heater can wells, groundwater wells, and monitoring wells in either the attached Heater Can Installation Construction Log and Well Construction Detail. The information required includes:

- Start and finish time(s)
- Depth of well installation/depth to bedrock
- Amount of water used, if any, during drilling
- Amount of grout used
- NAPL observed in soil, particularly in bottom 5-ft of overburden, but also in shallower soil (if any)
- Note volume of NAPL collected (if applicable)
- Note any deviations from the SOP and/or any characteristics specific to that well

RESPONSIBILITIES

The Site Supervisor, or his designee, will conduct periodic inspections of the installation procedures established by this SOP. The purpose of the inspection is to verify that the procedures and the requirements of the SOP are being followed. Any deviations or inadequacies that are identified during the inspection will be immediately corrected.

ATTACHMENTS

SRSNE Superfund Site Well Construction Details

Well Construction Detail

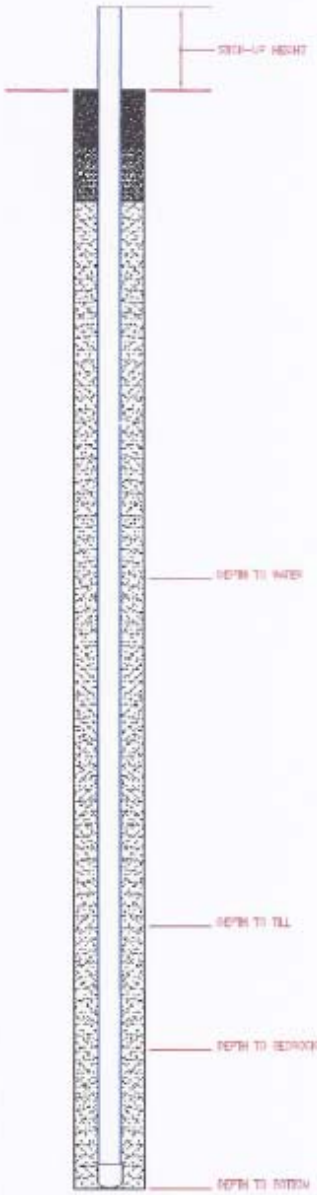
Five Star High Temp Grout Specs

SRSNE SUPERFUND SITE

13-101

WELL CONSTRUCTION DETAIL

DATE				PID READINGS	
WELL ID				TIME	PPM
DESIGN DEPTH TO BEDROCK	12	15	21		
DESIGN DEPTH OF BORING	16	19	25		
DESIGN LENGTH OF CAN	18	21	27		
DRILLER					
RIG NUMBER					
START TIME					
BEDROCK ENCOUNTERED AT			FT		
TIME BEDROCK ENCOUNTERED					
NAPL PRESENT					
TIME START PUMPING NAPL					
TIME FINISH PUMPING NAPL					
HO COMPLETION DEPTH			FT		
MODIFIED HO DEPTH					
MODIFIED HO LENGTH					
HO FINISH TIME					



NOTES:

		ARCADIS/*de maximis*	
		STAND BY	YES NO
ANY SUSTAINED PID READINGS?		TOTAL OF STAND BY	MINUTES
DRAGER TUBE TAKEN?		APPROVED BY	

Date:_____ TerraTherm ISTR #

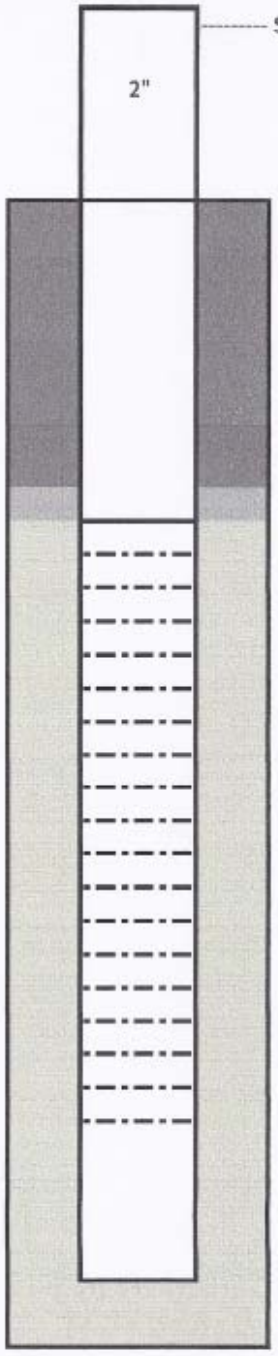
Southington, CT

Name: _____

Job # 13-101

Well Diameter 2"

--------- Stick Up Height_____



Ground Surface 0.0'----------

----- ***High temperature cement***

Casing Material
Carbon Steel

Screen Material
Stainless Steel

--- ***Top of #00 Fine sand*** _____

Slot Size
0.010

---- ***Top of Filter Pack***_____

---- ***Top of Screen*** _____

Borehole Diameter 6"

Start Time: _____

Stop Time: _____

---- ***Bottom of Screen*** _____

---- ***2' sump***

Depth to Bedrock: _____

---- ***Bottom of Well*** _____

---- ***Bottom of Borehole***_____

PRODUCT DESCRIPTION FOR HIGH TEMPERATURE GROUT (*note that this product may not be available at the time of wellfield installation and a similar high temperature grout will be used).*

Five Star® HTR Grout is a unique cement based grout for supporting equipment and structural base plates in high temperature environments. Five Star HTR Grout can be poured into place, gains strength rapidly and can be exposed to 1000°F (538°C) in 24 hours and up to 2400°F (1316°C) after a 7-day curing procedure. Five Star HTR Grout exhibits positive expansion when tested in accordance with ASTM C 827.

TYPICAL PLACEMENT GUIDELINES *Installation details may vary depending on field conditions*

1. SURFACE PREPARATION: All surfaces in contact with Five Star® HTR Grout shall be free of oil, grease, laitance and other contaminants. Concrete must be clean, sound and roughened to ensure a good bond. Soak concrete surfaces for 8 to 24 hours prior to application with liberal quantities of potable water, leaving the concrete saturated and free of standing water.

2. FORMWORK: Formwork shall be constructed of rigid non-absorbent materials, securely anchored, liquid-tight and strong enough to resist forces developed during grout placement. The clearance between formwork and baseplate shall be sufficient to allow for a headbox. The clearance for remaining sides shall be one to two inches (25 - 50 mm). Areas where bond is not desired must be treated with form oil, paste wax or similar material. Isolation joints may be necessary depending on pour dimensions. Contact Five Star Engineering and Technical Service Center for further information.

3. MIXING: Mix Five Star HTR Grout thoroughly for four to five minutes to a uniform consistency with a mortar mixer (stationary barrel with moving blades). A drill and paddle mixer is acceptable for single bag mixes. For optimum performance, condition between 60°F and 80°F (16°C and 27°C). Mix Five Star HTR Grout with 3 to 3 1/2 quarts potable water per 50 lb. bag. Working time is approximately 20 minutes at 70°F (21°C). Follow printed instructions on the package. Always add mixing water first to mixer followed by grout.

4. METHODS OF PLACEMENT: Five Star HTR Grout may be poured into place. Minimum placement thickness for Five Star HTR Grout is one inch (25 mm). For pours over three inches in depth Five Star HTR Grout should be extended with a clean damp coarse aggregate meeting the requirements of ASTM C 33. NOTE: Coarse aggregate must be suitable for high temperature exposure. Refer to the Five Star Technical Bulletin “Cement Grout Aggregate Extension” for guidelines.

5. POST-PLACEMENT PROCEDURES: Five Star HTR Grout shall be wet cured for a minimum of 30 minutes. Approximately three hours after placement, material can be brought up to an operating temperature of 1000°F (538°C). For operating temperatures up to 2400°F (1316°C), wet cure for 3 days followed by dry cure for 4 days. Then slowly apply heat up to 2400°F (1316°C).

NOTE: PRIOR TO APPLICATION, READ ALL PRODUCT PACKAGING THOROUGHLY. For more detailed placement procedures, refer to Design-A-Spec™ installation guidelines or call the Five Star Engineering and Technical Service Center at (800) 243-2206.

CONSIDERATIONS: If temperatures of equipment and surfaces are not between 40°F and 90°F (4°C and 32°C) at time of placement, refer to Design-A-Spec™ for cold and hot weather grouting procedures, or call the Five Star Engineering and Technical Service Center at (800) 243-2206. Substrate shall be free of frost and ice. Grout shall be protected from freezing until it reaches 1000 psi (6.9 MPa). Never exceed the maximum water content stated on the bag. Construction practices dictate concrete foundation should achieve its design strength before grouting.