RADIOLOGICAL GROUNDWATER MONITORING PROGRAM QUALITY ASSURANCE AND PROCEDURES
INDIAN POINT ENERGY CENTER
BUCHANAN, NEW YORK
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INDIAN POINT ENERGY CENTER
RADIOLOGICAL GROUNDWATER MONITORING PROGRAM
QUALITY ASSURANCE AND PROCEDURES

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INDIAN POINT ENERGY CENTER
RADIOLOGICAL GROUNDWATER MONITORING PROGRAM
QUALITY ASSURANCE AND PROCEDURES

Section 1: QUALITY ASSURANCE PLAN

GZA GeoEnvironmental is pleased to provide this Quality Assurance Plan (QAP) for the Radiological Groundwater Monitoring Program (RGMP) at Indian Point Energy Center (IPEC), as indicated in Task Order 32, dated March 5, 2007. This QAP describes the methods, procedures, and protocols that will be implemented by GZA's RGMP team in order to provide integrity of this Sampling Program. Included are details regarding use of Sampling Methods and Equipment, Waste Management Protocol, and Quality Assurance/Quality Control Procedures.

SAMPLING METHODS AND PUMPING EQUIPMENT

GZA will implement two methods of sampling to collect representative groundwater samples: the Low Flow method and a Modified Traditional method. The Low Flow method allows collection of groundwater samples indicative of ambient flow conditions at discrete sampling zones, while minimizing the accumulation of wastewater. Wastewater is minimized by limiting pumping rate and drawdown. The Modified Traditional method allows for the collection of groundwater samples from monitoring wells where low-flow sampling cannot be implemented, while still minimizing wastewater accumulation. As agreed upon by GZA, Entergy Nuclear Northeast, the Nuclear Regulatory Commission (NRC), and the New York State Department of Environmental Conservation (NYSDEC), the Modified Traditional method allows for collection of groundwater samples after purging 1.5 well volumes. This method will only be implemented in one or two inch diameter wells in which low flow sampling cannot be achieved.

Several types of pumping equipment will be utilized, depending upon the sampling method to be used and the characteristics of individual monitoring wells. Appendix B lists each monitoring well under consideration for the Radiological Groundwater Monitoring Program, and the suggested sampling method and equipment for each well. The rationale for choice of sampling methods and equipment are as follows:

- Open rock wells at least 200 feet in depth should be low flow sampled using permanently installed Solinst Waterloo Multilevel Sampling systems.
- One inch wells in which static water level is deeper than 25 feet should be sampled using the Modified Traditional method with a Waterra Pump and footvalve.
- In general, low-yielding wells may be sampled using the Modified Traditional method if drawdown cannot be minimized using the Low Flow method. This may be implemented using a peristaltic pump, submersible pump, or Waterra pump and footvalve.

- Adequately yielding wells two inches or greater in diameter in which static water level is deeper than 25 feet should be low flow sampled using a submersible pump.
- Adequately yielding wells in which depth to static water level is less than 25 feet should be low flow sampled using a peristaltic pump.

WASTE MANAGEMENT

The following wastes will be generated as part of the Long Term Monitoring and Sampling Program at IPEC: 1) monitoring well purge water; 2) decontamination water; and 3) disposable sampling equipment.

Monitoring Well Purge Water

Generation of monitoring well purge water will be minimized by implementing the low flow sampling method whenever possible. Purge water generated from MW38, MW40, MW48, and MW51 will be discharged to ground surface until further notice from Entergy. Purge water collected from all other wells will be collected and contained in appropriate containers issued by Entergy. Drums and containers will be clearly labeled with a description and source of its contents. Removal of drums or containers and treatment and disposal of wastewater will be the sole responsibility of Entergy.

Decontamination Water

Wastewater generated from the decontamination of tools, reusable supplies, and field screening equipment such as water quality meters, water level indicators, oil/water interface probes, and flow meters will be collected and contained in appropriate containers issued by Entergy. Drums and containers will be clearly labeled with a description and source of its contents. Removal of drums or containers and treatment and disposal of wastewater will be the sole responsibility of Entergy.

Disposable Sampling Equipment

Disposable sampling equipment including latex gloves, disposable tubing, and disposable bailers will typically be collected in plastic trash bags, and disposed of in appropriate on-Site trash facilities. As requested by Entergy, disposable sampling equipment used at specified wells, such as MW42 and MW53, will be evaluated by a Health Physics professional prior to disposal. Disposable sampling equipment used within Radiologically Controlled Areas will be collected and sealed in transparent "Radioactive Trash" bags and disposed of in Radiologically Controlled Area trash facilities.

QUALITY ASSURANCE/QUALITY CONTROL (QA/QC) PROCEDURES

QA/QC procedures will be used to provide performance information with regard to accuracy, precision, sensitivity, representativeness, completeness, and comparability associated with the sampling and analysis activities to be conducted as part of this Monitoring Program. Field QA/QC procedures will be used to ensure that samples collected are representative of the actual conditions of the Site, and do not contain contaminants introduced either from the field activities or from sample transit. A summary of the field and laboratory QA/QC procedures to be followed as part of this Investigation is given below.

Field QA/QC

Field QA/QC will include the following procedures:

- Calibration of Field Equipment
- Collection of Field QA/QC Samples
- Use of Dedicated and Disposable Field Sampling Equipment
- Proper Sample Handling and Preservation
- Proper Sample Custody Procedures in the Field
- Proper Chain of Custody Documentation
- Completion of Report Logs

A description of each of these procedures is provided below.

Calibration of Field Equipment

Calibration of field analytical equipment, including water quality meters and turbidity meters, will be checked on a daily basis and recalibrated in accordance with factory instructions as needed.

Collection of Field QA/QC Samples

Submersible pumps removed from monitoring wells will be decontaminated and a 500mL field QA/QC blank will be collected prior to reinstallation. The field QA/QC blank will be collected by circulating fresh water through the decontaminated pumps and gathering this water into appropriate sample containers.

Additionally, one field sample will be collected each quarter for laboratory spiking and subsequent analysis.

Use of Dedicated and Disposable Field Sampling Equipment

Dedicated polyethylene or nylon tubing (or equivalent) will be used in all monitoring wells to eliminate the possibility of cross-contamination during groundwater sampling activities.

Monitoring wells MW30, MW31, MW32, MW39, MW40, MW51, MW52, MW54, MW60, MW62, MW63, and MW67 will be sampled using permanently installed multilevel sampling systems utilizing dedicated ¼" nylon tubing and double-valve pumps.

Monitoring wells MW42-49, MW44-63, MW45-42, MW47-56, MW53-82, MW56-53 will be sampled using a submersible pump and dedicated 3/8 x 1/2 inch polyethylene tubing (or equivalent) that will be stored in the wells during periods of non-use.

Monitoring wells MW41-63, MW42-78, MW44-102, MW45-61, MW47-80, MW53-120, and MW56-83 will be sampled using dedicated 5/8 x ½ inch high density polyethylene tubing (or equivalent) and dedicated stainless steel or Teflon footvalves. This tubing and footvalves will be dedicated to individual wells, but, in between uses, will be sealed and stored in labeled plastic bags instead of within respective wells.

All other monitoring wells will be sampled using a peristaltic pump and dedicated ¼" nylon or 3/8 x ¼" polyethylene tubing (or equivalent.)

Each well sampled using the low flow method will also have a dedicated flow restriction valve.

Short lengths of flexible tubing for the peristaltic pump and nylon or polyethylene tubing used to connect monitoring equipment will be disposed of after each use. Other disposable equipment including nitrile gloves and disposable bailers will be used to prevent cross-contamination between samples. Nitrile gloves will be changed frequently and in between wells.

Sample Handling and Preservation

Sample volumes collected will be predetermined by Entergy. For each of the analytical parameters analyzed, a sufficient sample volume will be collected to allow the specified analytical method to be performed according to protocol, and to provide sufficient sample for reanalysis if necessary, unless an agreement is reached between receiving parties to increase or decrease the sample volume(s) requested.

Samples will be collected in high density polyethylene or polypropylene containers such as Nalgene brand or equivalent. If a split sample is required, all requested sample volumes will be combined into one large container, thoroughly mixed, and then divided into the appropriate volume containers for each receiving party.

Sample preservation techniques such as cold temperature storage at 4° C and pH adjustment with hydrochloric acid are not necessary for analysis of radionuclides and thus will not be utilized. There is no holding time for analysis of radionuclides, but samples will be relinquished to an Entergy-issued receiver promptly after collection.

Packaging and shipping of samples for laboratory analysis will be the sole responsibility of Entergy.

Sample Custody in the Field

Sample handling in the field will conform to appropriate sample custody procedures. Field custody procedures include proper sample identification, chain-of-custody forms, and delivery procedures. Sample labels will include monitoring well nomenclature, sampling port depth (when appropriate), sample number, date, time, sampler's name, and sample designation when a split between parties is required. Additionally, custody seals may be placed around the sample bottle lid to detect unauthorized tampering between time of collection and analysis. The seals should be attached in such a way that it will be necessary to break them in order to open the container.

After each sample is collected and appropriately identified, the following information will be entered into a chain-of-custody form:

- site name and address (if not pre-printed)
- sampler(s)' name(s)
- monitoring well nomenclature and port depth when appropriate
- sample number
- number of containers
- date and time of sample completion
- type of sample
- sample matrix

Sample analyses required will be entered by Entergy.

During split sampling events, separate chain-of-custody forms will be filled out for each receiving party. Example chain-of-custody forms issued by Entergy, the NRC, and NYSDEC are presented in Appendix C.

The sampler will sign and date the "Relinquished by" blank space, photocopy the chain of custody, and either A) relinquish the samples and original chain to the appropriate designee representatives who will sign and date the "Received by" blank space; or B) deliver the samples and original chain to the designated sample locker issued by Entergy. The sampler will retain a copy of the chain of custody.

Sample details will then be logged into a computerized information database.

Chain of Custody QA/QC

Samples delivered to the designated sample locker will be accompanied by an original signed and dated chain of custody. Samples will be received by Entergy shipping personnel who will inspect the sample bottles and custody seals to check their integrity, and examine the information on the chain-of-custody form. If the samples in the locker match those described on the chain-of-custody form, the Entergy shipping personnel will sign and date the form on the next "Received" blank and assume responsibility for the samples. The samples may then be appropriately packaged and shipped in accordance with Entergy and NRC procedures.

If issues with the samples are noted, the Entergy shipping personnel will sign the form and record problems in the "Remarks" box. He/she will then immediately notify the Project Site Supervisor by telephone (Sara Covelli 646-294-7359) so appropriate follow-up steps can be implemented on a timely basis.

If samples are relinquished by the sampler to a third party designee immediately following sample collection, the sampler and third party shall sign and date the chain of custody and the sampler will relinquish samples to the designee. The sampler will then proceed with the chain of custody to the nearest facility to make photocopies of the chain. The sampler will provide the original chain of custody for the designee and a copy for a designated Entergy representative. The sampler will also keep at least one photocopy of the chain for GZA.

If samples are to be relinquished by the sampler to more than one party immediately following sample collection, each set of samples relinquished will be documented by a separate chain-of-custody form in accordance with NRC and NYSDEC chain-of-custody procedures.

Laboratory QA/QC

Laboratory custody procedures for sample receiving and log-in, sample storage and numbering, tracking, sample preparation and analysis, QA/QC, and storage of data are described in the laboratory's Standard Operating Procedure (SOP). This document is available upon request.

Field Report Logs

The following logs or their equivalent will be completed during the course of this program: 1) Daily Field Activities Logs; 2) purging and sampling data logs; and 3) Transducer Installation Logs.

The Daily Field Activities Log should be completed at the end of each day and will describe field activities including:

- project number and site name
- date and times of GZA samplers' onsite arrival and departure
- weather
- attendees onsite and associated affiliations
- description of field activities
- all pertinent sample collection information including-
  - -sample identification numbers
  - -well nomenclature
  - -number of samples taken
  - -method of sample collection
  - -equipment used
  - -any factors that may affect sample quality
  - -time of sample collection
  - -initials of collector
- well nomenclature of any transducer installations, alterations, or data collected
- notes regarding significant meetings, concerns, and inventory

One of three types of sampling data sheets (Low Flow, Waterloo, or Modified Traditional Purge) or their equivalent should be completed during purging and sampling of each monitoring well (Appendix D). The type of sampling data sheet used will be appropriately chosen based on method of sampling and equipment used.

The following information should be recorded on the sheets:

- project number, site name and location
- monitoring well nomenclature
- date
- sampler's name
- well casing diameter
- well depth from top of casing
- top of casing elevation
- static water level
- equipment used and serial number of equipment
- start and end times of purging and sampling

- water quality parameter readings including-
  - -pH
  - -temperature
  - -specific conductivity
  - -dissolved oxygen
  - -ORP
  - -turbidity
- time of readings
- volume of water purged by the time of each reading

The following additional information may be recorded depending on the individual monitoring well and type of sampling performed:

- water level readings, if possible
- distance from top of well casing to water and free product
- flow rate of purge and/or pump settings
- height of water column
- desired purge volume

A Transducer Installation Log should be completed for each transducer installed or reset. The following information should be recorded on each log:

- project number, site name and location
- monitoring well nomenclature
- date
- technician's name
- well casing diameter
- well depth from top of casing
- top of casing and ground surface elevation
- static Depth to Water and time measured
- transducer depth readings
- groundwater elevation reference set
- test interval
- test name programmed
- time of test start
- transducer serial number

Section 2: LOW-FLOW SAMPLE COLLECTION

PURPOSE

To obtain representative groundwater samples for radionuclide analysis at Indian Point Energy Center as part of Entergy's Radiological Groundwater Monitoring Program (RGMP). The low-flow sampling method allows collection of groundwater samples indicative of ambient flow conditions at discrete sampling zones, while minimizing the accumulation of wastewater. Wastewater is minimized by limiting pumping rate and drawdown. This Site-specific Standard Operating Procedure (SOP) describes the low-flow sampling procedure as defined by applicable portions of the United States Environmental Protection Agency (USEPA). The procedure contained within this SOP will be used during implementation of the RGMP.

EQUIPMENT AND MATERIALS

- Peristaltic pump or dedicated submersible pump and control
- Dedicated ¼ nylon or 3/8 inner diameter polyethylene tubing
- Water level indicator and/or pressure transducer
- In-line flow meter
- Flow-restriction valve
- Oil-water interface probe (if necessary)
- Power source/ generator
- Air compressor, air flow regulator, and air line (for Waterloo systems)
- Water quality meter with manual-read and logging capability (ph, ORP, DO, specific conductance, and temperature) with flow-through cell
- Turbidity meter
- 1 gallon purge water bottles
- Field book
- Sampling log
- Well-construction log
- Sample bottles (1 gal and/or 2 liter)
- Collapsible sample bottles (2.5 gal)
- Decontamination supplies
- Exclusion zone/ safety materials (stanchions, caution signs, and rope)
- Personal Protective Equipment (nitrile gloves, safety glasses, hard hat, safety-toe shoes, hearing protection when required)
- Watch
- Appropriate batteries for applicable equipment
- Liquinox Soap
- Zip Lock bags
- Indelible marking pen and black ink pen
- Copy of Site-Specific Health and Safety Plan (Appendix A)

- Copy of owner's manual for sampling equipment
- This SOP
- Chain of Custody forms
- Calculator
- Cell Phone

Sample preservation is not required for analysis of radionuclides, and thus, the use of preservatives, ice, and other sample preservation techniques are not addressed in this Site-Specific SOP. Additional equipment and materials may be needed for evaluation of non-radionuclides.

EQUIPMENT INSTALLATION AND PLACEMENT

Recognizing that there are several types of monitoring wells at the Site, there will necessarily be different approaches to groundwater sampling. General sampling considerations include the following:

- In order to minimize disturbance of the water column, install dedicated tubing and/or dedicated pumps at least 24 hours prior to sampling.

- Boreholes containing permanent Waterloo Multilevel Sampling Systems will be low-flow sampled using the Waterloo system's double-valve pumps and dedicated ¼ inch nylon tubing.

- Monitoring wells with a diameter of two inches or greater and a depth to water greater than 25 feet will typically be sampled with a dedicated variable-speed submersible pump and dedicated 3/8 inch ID polyethylene tubing or equivalent. One inch wells with static groundwater levels deeper than 25 feet will be sampled using the Modified Traditional Groundwater Sampling Method, as outlined in Section 3.

- Wells with static groundwater levels no more than 25 feet below ground surface will typically be sampled using a variable-speed peristaltic pump and dedicated ¼ inch ID nylon tubing or equivalent.

- In wells with an open sampling interval or screen length of 10 feet or less, position the pump intake or end of tubing at the midpoint of the sampling interval. If possible, place the intake at least two feet from the bottom of the well to avoid disturbance of settled particulates. In open boreholes and other wells with an open sampling interval greater than 10 feet, the intake point shall be placed at a predetermined depth intended to capture one or more discrete sample/fracture zones.

- In-line monitoring and flow rate equipment should be attached to dedicated tubing in the following order: flow restriction valve (for non-waterloo wells), peristaltic pump (if required), flow meter, water quality meter/flow through cell.

PROCEDURES

1. In non-Waterloo wells, use an in-line flow meter measuring flow in gallons per hour to determine flow rate. Use pump speed control and a dedicated flow restriction valve to adjust flow rate. Pumping rates/pressures should be adjusted ideally within the first fifteen minutes of purge to expedite stabilization.

2. Use a turbidity meter, water quality meter, and in-line flow through cell to evaluate water quality parameters for stabilization. Wastewater may be discharged from flow through cell directly into an appropriate container provided by Entergy. If this is not possible, wastewater may be discharged into one gallon containers designated for wastewater and labeled "Purge Only". Special caps that hold discharge tubing in place have been fabricated by GZA for these containers. These one gallon containers will be discharged to larger containers when full. Large wastewater containers should only be filled to a maximum of 80%.

3. Establishing Low-Flow:

   A) *Non-Waterloo Wells*

   i. Check that transducers are recording water-level measurements prior to pumping.

   ii. Measure depth to groundwater to the nearest one-hundredth of a foot (0.01') using a water level indicator. Take all depth to water measurements from top of well casing at the point marked on the riser. If there is no mark, use an indelible black marker to mark the northern-most point on the riser. If LNAPL (Light Non-Aqueous Phase Liquid) or DNAPL (Dense Non-Aqueous Phase Liquid) exists in the well, use an oil/water interface probe to measure depth to product and depth to groundwater. Record measurements in field book and on sampling data sheet.

   iii. Start the pump at its lowest speed setting and slowly increase until discharge occurs. Adjust flow-restriction valve to limit rate of flow.

   iv. Take a water level measurement and adjust setting until drawdown is 0.3 feet or less. If drawdown of 0.3 feet or less cannot be achieved, set pump speed as slow as possible and take water level measurements until water level stabilizes.

   v. Avoid allowing the water level to fall to the intake level or to within the screen (if static water level is above the screen.)

vi. Flow rate should not exceed 4 gallons per hour. Continue to take water level and flow rate measurements every 3 to 5 minutes.

B) *Waterloo Wells*

i. Check that transducer data-loggers are recording water-level measurements prior to pumping.
ii. Start the air flow regulator at its lowest pressure setting using short drive/vent cycles (4-5 seconds). Slowly increase pressure until discharge occurs.
iii. Adjust drive/vent cycle and pressure until air is completely purged from the discharge line. If air returns to the discharge line during the course of the purge, the maximum depressurization threshold of the sample zone has been surpassed, and purging must be slowed or momentarily suspended to allow recharge.
iv. Record drive/vent cycle times and pressures to reference for future sampling events.
v. If air passes through discharge tubing at any point during purge, suspend monitoring of water quality parameters and reduce the rate of purge.
vi. Resume water quality parameter monitoring when air has completely cleared from the tubing and one full flow-through cell volume of water has been discharged.

4. Stabilization is complete when three consecutive readings taken at 5-minute intervals fall within the following limits:

Turbidity	10 %
Dissolved Oxygen	10 %
Specific Conductance	3 %
Temperature	3 %
pH	+/- 0.1 unit
ORP	+/- 10 mVolts

5. If after four hours of continuous purging, parameters have not stabilized, call the project manager to discuss the most appropriate course of action.

6. When stabilization of water quality parameters has been achieved, extract a sample only if one full tubing volume has already been purged. The following standard will be used to calculate this volume:

Sampling Intake Depth < (less than) 100ft	¼ gallon
Sampling Intake Depth > (greater than) 100ft	½ gallon

7. When stabilization has been achieved and the appropriate volume has been purged, collect a sample at the same rate of purge used to achieve stable water quality parameters. Remove water quality meters and flow meters from the discharge tube prior to collecting the sample. Water that has passed through water quality and/or flow meters may not be used for sampling.

8. GZA sampling technicians may stabilize parameters, but will not begin sample collection until the required parties, such as Entergy representatives, Health Physicians (HP), Nuclear Regulatory Commission (NRC), and the NY State Department of Environmental Conservation (NYSDEC), have arrived for observation.

9. Label sample bottles with the following information:

   Well ID
   Port ID (for waterloo wells)
   IPEC Sample Number (as provided by Entergy)
   Date
   Time (of Sample Start)
   GZA Technician's Name
   Designation (ie: IPEC, NRC, DEC, etc)

10. In non-waterloo wells, after the samples have been collected and pumps have been turned off, measure depth to water from the top of well casing and record on sampling log.

RECORDS AND DOCUMENTATION

All data and sampling information must be recorded on a Low-Flow Sampling or Waterloo Sampling Data Sheet or equivalent (included as Appendix D). This must minimally include the following water quality parameters: pH, ORP, dissolved oxygen, turbidity, temperature, and specific conductance. Also record date, times, depth to water, flow rate (or vent/drive cycle), and special notes on the Data Sheet. General information such as date, time, well name, initial depth to water measurements, issues encountered/actions taken, communications, and parties present during sampling should also be recorded in a field log book.

EQUIPMENT FAILURE AND OTHER POTENTIAL PROBLEMS

- Pump Failure During Sample Collection: If pumping ceases and water in the tubing is allowed to flow back into the well before sample collection has been completed, any partial sample volume collected should be discarded. When pumping is resumed, 3 new consecutive stabilized readings must be achieved prior to new sample collection. A new container should be used to collect the new sample.

- Submersible Pump Failure: If submersible pump failure occurs during purging or sampling, check battery power and pump controller fuses. If purging cannot be resumed using the submersible pump, do not remove the pump or tubing from the well. If the depth to water is greater than 25 feet, call the project manager to discuss the most appropriate course of action. If depth to water is less than 25 feet, attach a short length of flexible tubing to the end of the submersible pump tubing and use a peristaltic pump to continue purge. Three new consecutive stabilized readings must be achieved before sample collection.

- Peristaltic Pump Failure: If peristaltic pump failure occurs during purging or sampling, check battery power and condition of flexible tubing. If purging cannot be resumed, replace peristaltic pump.

- Water Quality Monitoring Equipment Failure: If water quality meter or turbidity meter fails or reads in error during purging, continue purging and replace failed equipment. If replacement equipment is not available, call the project manager to discuss the most appropriate course of action.

- Flow Meter Failure: If flow meter fails during purging, continue purging and gauge flow rate using a stopwatch and a calibrated container (such as a measuring cup).

- Failure to Stabilize Water Quality Parameters: If water quality parameters do not stabilize after four hours of continuous purging, one of four options may be considered.

  a) Continue purging and attempt to stabilize readings
  b) Discontinue purging, do not collect a sample, and document efforts to stabilize water quality parameters.
  c) Discontinue purging and collect a sample. Document efforts to stabilize readings.
  d) Discontinue purging and secure the well. Resume purge the next day and attempt to stabilize readings.

  Call the project manager to discuss the most appropriate of these four options.

- Insufficient Yield: If the recharge rate of a well is less than the slowest extraction rate achievable, and the well is completely dewatered, suspend purging and extract a sample as soon as the well has recovered sufficient volume to fill the required sample volume.

- Call the project manager if other difficulties arise. All problems will be documented on the sampling data sheet and field book.

POST SAMPLING ACTIVITIES

1. Leave dedicated equipment including pumps, tubing, and pressure transducers in individual wells to avoid cross-contamination.

2. Decontaminate flow meters, water quality meters, turbidity meters, and flow-through cells between samples with a three step process: pre-rinse, wash, rinse. Pre-rinse equipment by flushing with fresh water in a clean 5 gallon bucket or equivalent container. Wash equipment in another container with a liquinox-solution. Rinse equipment with fresh water in a third container. Containerize all decontamination liquid in an appropriate wastewater container provided by Entergy.

3. Thoroughly decontaminate water level indicators and oil-water probes using bleach or alconox wipes followed by a fresh water rinse. Containerize decontamination liquid in an appropriate wastewater container provided by Entergy.

4. Prior to the next sampling event, check calibration of water quality meters against a calibration standard and recalibrate as necessary using parameter-specific buffers (see attached calibration procedures in Appendix E).

SAMPLE HANDLING AND CHAIN OF CUSTODY DOCUMENTATION

After collection of samples has been completed and the work area has been secured, a GZA sampling technician will deliver samples to a designated locker provided by Entergy and/or designated party. A chain-of-custody record will document sample names, name of samplers, sample matrix, number of containers, date and time of sample completion, and the analysis required. The chain-of-custody will be completed by the GZA sampling technician(s) and will be delivered to either the designated sample locker or an appropriate Entergy representative at the end of each sampling day. Each person or organization who relinquishes and/or receives responsibility for the samples will sign, date, and retain one copy of the record for his/her files.

APPLICABLE REFERENCES AND STANDARDS

U.S. Environmental Protection Agency, Region II, "Ground Water Sampling Procedure Low Stress (low flow) Purging and Sampling," March 16, 1998.

Section 3: MODIFIED TRADITIONAL GROUNDWATER SAMPLE COLLECTION

PURPOSE

To obtain representative groundwater samples for radionuclide analysis at Indian Point Energy Center as part of Entergy's Radiological Groundwater Monitoring Program (RGMP). The Modified Traditional Sampling method allows for the collection of groundwater samples from monitoring wells where low-flow sampling cannot be implemented, while minimizing the accumulation of wastewater. This Site-Specific SOP describes the RGMP's Modified Traditional Sampling procedure as agreed upon by GZA, Entergy Nuclear Northeast, the Nuclear Regulatory Commission (NRC), and the New York State Department of Environmental Conservation (NYSDEC). The procedure contained within this SOP will be used during implementation of the RGMP.

EQUIPMENT AND MATERIALS

- Waterra pump
- 5/8" ID (female thread) stainless steel footvalve
- Dedicated ½" ID (5/8 OD) high-density polyethylene tubing
- Water level indicator
- Oil-water interface probe (if necessary)
- Power source/ generator
- Water quality meter with flow-through cell
- 1 gallon purge water bottles
- Field book
- Sampling log
- Well-construction log
- Sample bottles (1 gal or 2 liter)
- Collapsible sample bottles (2.5 gal)
- Decontamination supplies
- Exclusion zone/ safety materials (stanchions, caution signs, and rope)
- Personal protective equipment (nitrile gloves, safety glasses, hard hat, safety-toe shoes, hearing protection when required)
- Watch
- Appropriate batteries for applicable equipment
- Liquinox Soap
- Zip Lock bags
- Indelible marking pen and black ink pen
- Copy of Site-Specific Health and Safety Plan (Appendix A)
- Copy of owner's manual for sampling equipment

- This SOP
- Chain of Custody forms
- Calculator
- Cell Phone

Sample preservation is not required for analysis of radionuclides, and thus, the use of preservatives, ice, and other sample preservation techniques are not addressed in this Site-Specific SOP. Additional equipment and materials may be needed for evaluation of non-radionuclides.

EQUIPMENT INSTALLATION AND PLACEMENT

Recognizing that there are several types of monitoring wells at the Site, there will necessarily be different approaches to groundwater sampling. General sampling considerations include the following:

One inch diameter wells with static groundwater levels more than 25 feet deep will typically be sampled using this Modified Traditional Groundwater Sampling method. Wells with recharge rates too slow to implement the Low-Flow Procedure should also be sampled using the Modified Traditional method. Other wells on site will typically be sampled using the low flow method as outlined in Site-Specific SOP Low Flow Sampling Procedure described in Section 2.

In wells with an open sampling interval or screen length of 10 feet or less, the intake point will typically be positioned at the midpoint of the sampling interval. In wells with an open sampling interval greater than 10 feet, the intake point shall be placed at a predetermined depth intended to capture one or more discrete sample/fracture zones.

To avoid cross-contamination between wells and to minimize waste generated during sampling events, tubing and footvalves will be dedicated to the individual wells sampled using this method. However, due to the narrow diameter of these wells, tubing and footvalves will not be stored in the wells between sampling events. Dedicated pressure transducers will be removed from the wells during sampling and reinstalled between sampling events to log groundwater elevation data at regular intervals. Dedicated tubing and footvalves will be sealed in individual plastic bags labeled with the well ID. These plastic bags will be stored by GZA in a location approved by Entergy.

PROCEDURES

1. Prior to the removal or installation of any equipment in the well, measure depth to groundwater to the nearest one-hundredth of a foot (0.01') using a water level indicator. Take all depth to water measurements from top of well casing at the point marked on the riser. If there is no mark, use an indelible black marker to mark the Northern-most point on the riser. If LNAPL (Light Non-Aqueous Phase Liquid) or DNAPL (Dense Non-Aqueous Phase Liquid) exists in the well, use an oil/water interface probe to measure depth to product and depth to groundwater. Record measurements in field book and on sampling data sheet.

2. Remove the dedicated pressure transducer from the well and store in a clean plastic bag. Again, measure and record depth to groundwater.

3. Install dedicated tubing and footvalve into the well and discard the plastic bag used to store the tubing.

4. Affix tubing to waterra pump and attach flow through cell and water quality meter to the end of tubing.

5. Wastewater may be discharged from flow through cell directly into wastewater containers provided by Entergy. If this is not appropriate, wastewater may be discharged into one gallon containers designated for wastewater and labeled "Purge Only". Special caps that hold discharge tubing in place have been fabricated by GZA for these containers. These one gallon containers will be discharged to larger containers when full. Large wastewater containers should only be filled to a maximum of 80%.

6. Prior to collection of samples, 1.5 well volumes should be purged. Use the water quality meter and turbidity meter to measure water quality parameters. Water quality parameters need not be stabilized prior to sampling, but should be measured approximately every 5 minutes and recorded on the sampling data sheet.

7. When 1.5 well volumes have been purged, a sample may be collected. Remove water quality meters from the discharge tube prior to collecting the sample. Water that has passed through water quality and/or flow meters may not be used for sampling.

8. GZA sampling technicians may purge the appropriate volume, but will not begin sample collection until the required parties, such as Entergy representatives, Health Physicians (HP), Nuclear Regulatory Commission (NRC), and the NY State Department of Environmental Conservation (NYSDEC), have arrived for observation.

9. Label sample bottles with the following information:

Well ID
IPEC Sample Number (as provided by Entergy)
Date
Time (of Sample Start)
GZA Technician's Name
Designation (ie: IPEC, NRC, DEC, etc)

RECORDS AND DOCUMENTATION

All data and sampling information should be recorded on a Modified Traditional Purge Method Sampling Data Sheet (Appendix D) or equivalent. This will typically include the following water quality parameters: pH, ORP, dissolved oxygen, turbidity, temperature, and specific conductance. Also record date, times, initial and final depth to water measurements, and special notes on the Data Sheet. General information such as date, time, well name, initial depth to water measurements, and parties present during sampling should also be recorded in a field log book.

EQUIPMENT FAILURE AND OTHER POTENTIAL PROBLEMS

- Pump Failure: If waterra pump fails during purge or sampling, continue purging and complete sampling event by hand.
- Water Quality Monitoring Equipment Failure: If water quality meter or turbidity meter fails or reads in error during purging, continue purging and replace failed equipment. If replacement equipment is not available, continue purging and collect sample after 1.5 well volumes have been purged. Document equipment failure or errors on the sampling data sheet and field book.
- Insufficient Yield: If the recharge rate of a well is less than the extraction rate, and the well is completely dewatered, suspend purging and extract a sample as soon as the well has recovered sufficient volume to fill the required sample volume.
- Call the project manager if other difficulties arise. All problems should be documented on the sampling data sheet and field book.

POST SAMPLING ACTIVITIES

1. After the samples have been collected, remove tubing and footvalve from the well. During removal of tubing and footvalve, drain the tubing into an appropriate wastewater container. Measure depth to water from the top of well casing, and record on sampling log with the time of measurement.

2. Store tubing and footvalve in the plastic bag containing the pressure transducer. Seal and label the plastic bag with the well ID. Reinstall pressure transducer in the well. Measure depth to water from the top of well casing, and record on sampling log with the time of measurement.

3. Decontaminate water quality meters, turbidity meters, and flow-through cells between samples with a three step process: pre-rinse, wash, rinse. Pre-rinse equipment by flushing with fresh water in a clean 5 gallon bucket or equivalent container. Wash equipment in another clean container with a liquinox-solution. Rinse equipment with fresh water in a third clean container. Containerize all decontamination liquid in an appropriate container provided by Entergy.

4. Thoroughly decontaminate water level indicators and oil-water probes using bleach or alconox wipes followed by a fresh water rinse. Containerize decontamination liquid in an appropriate container provided by Entergy

5. Prior to the next sampling event, check calibration of water quality meters against a calibration standard and recalibrate as necessary using parameter-specific buffers (see attached calibration procedures in Appendix E).

SAMPLE HANDLING AND CHAIN OF CUSTODY DOCUMENTATION

After collection of samples has been completed and the work area has been secured, a GZA sampling technician will deliver samples to a designated locker provided by Entergy and/or designated party. A chain-of-custody record will document sample names, name of samplers, sample matrix, number of containers, date and time of sample completion, and the analysis required. The chain-of-custody will be completed by the GZA sampling technician(s) and will be delivered to either the designated sample locker or an appropriate Entergy representative at the end of each sampling day. Each person or organization who relinquishes and/or receives responsibility for the samples will sign, date, and retain one copy of the record for his/her files.

APPENDIX A

GZA Site-Specific Health, Safety, and Accident Prevention Plan

GENERAL INFORMATION

Client/Site Name:	Entergy / Indian Point Energy Center (IPEC) Buchanan, NY
Site Address:	450 Broadway, Buchanan, NY 10511
Job/Project #:	41.0161619.00
Estimated Start Date:	June 1, 2007 — Estimated Completion Date: December 31, 2007

EMERGENCY INFORMATION

Phone Numbers:	Hospital #:	(914) 737-9000	Ambulance #:	911
	Fire #:	911	Police #:	911

Hospital Name & Address: Hudson Valley Hospital Center
1980 Crompton Road
Cortland Manor, NY 10567

Directions and Street Map of Route to Nearest Hospital Attached: ☒ Yes ☐ No (if no, do not proceed)

Other Emergency Contact: Sara Covelli Phone #: [redacted]

Location of Nearest Phone: [redacted] (Hany Guirguis- Cell Phone) [redacted] (Miguel Britos- Cell Phone)

Have Necessary Underground Utility Notifications for Subsurface Work Been Made? ☐ Yes ☒ Not Applicable

Specify Clearance Date & Time, Call Before You Dig Clearance I.D. #, And Other Relevant Information: No subsurface work will take place.

SCOPE OF WORK

Site Description:	Various locations within the Operator Controlled Area (OCA), Protected Area (PA), and Radiologically Controlled Area (RCA) of a nuclear generating facility.
Specific Tasks Performed by GZA:	Transducer Installation and Monitoring Sampling Equipment Installation Routine Groundwater Sampling Well Maintenance
Concurrent Tasks to be Performed by GZA Subcontractors (List Subcontractors by Name):	1. Aquifer Drilling and Testing, Inc: Vacuum Excavation; Drilling; Monitoring Well Installation; Multilevel Sampling System Installation; Packer Tests 2. Geophysical Applications: Geophysical well logging
Concurrent Tasks to be Performed by Others:	Daily plant operations and maintenance. Construction. Operation of heavy machinery.

Does this project include confined space entry? ☒ yes ☐ no

GZA ON-SITE PERSONNEL

Name	Project Title/Assigned Role	Telephone Numbers
Matthew Gozdor	Project Manager	work: 734-779-2404 cell: [redacted]
Sara Covelli	Site Supervisor Site Safety Officer/Competent Person Project Engineer	work: 212-594-8140 cell: [redacted] home: [redacted]
Hany Guirguis	Sampling Technician	work: 347-758-3812
Miguel Britos	Sampling Technician	work: 347-582-0408

Site Supervisors and Project Managers (SS/PM): Responsibility for compliance with GZA Health and Safety programs, policies, procedures and applicable laws and regulations is shared by all GZA management and supervisory personnel. This includes the need for effective oversight and supervision of project staff necessary to control the Health and Safety aspects of GZA on-site activities.

Site Safety Officers and Competent Persons (SSO/CP): The Site Safety Officer (SSO) or "Competent Person", as defined by OSHA 1926.20(b) - Accident Prevention Responsibilities, is the individual "who is capable of identifying existing and predictable hazards in surroundings or working conditions which are unsanitary, hazardous, or dangerous to employees, and who has authorization to take prompt corrective measures to eliminate them." The SSO is designated on a site-by-site basis based on the site conditions, scope-of-work, and the individual's ability to recognize site-specific hazards and take appropriate corrective actions. This individual is responsible to both project management and the designated HSC with regard to the completion of these assigned duties.

First Aid Personnel: In accordance with OSHA 1926.50, at least one individual designated by GZA who has current (Red Cross or equivalent) training and certification in basic first aid and cardiopulmonary resuscitation (CPR) must be present during on-site activities involving multiple GZA personnel. This person must also have received training and information regarding GZA's Bloodborne Pathogen control program, including the required use of "universal precautions" and the availability of HBV vaccinations.

Staff: Ultimate control of Health and Safety is in the hands of each individual employee. Therefore, each employee must become familiar with and comply with all Health and Safety requirements associated with their position and daily operations. Employees also have the responsibility to notify the appropriate management, SSO and HSC of unsafe conditions and accidents/injuries immediately. When employees are issued respirators or any other personal protective equipment (PPE), they are responsible for ensuring that said items are used properly, cleaned as required and maintained in good working order.

(Sub)contractors: (Sub)contractors must develop their own accident prevention plan related to their specific on-site activities. Subcontractors may use GZA's plan as an informational model. However, each Subcontractor is responsible for determining the plan's adequacy and applicability to its own activities on site. Subcontractors must deliver their plan in clear written form to GZA prior to the initiation of on-site activities.

OTHER PROJECT PERSONNEL:

Name	Project Title/Assigned Role	Telephone Numbers
Matthew Barvenik	Associate/Principal-in-Charge	work: 781-278-3805 cell: [redacted]
Matthew Gozdor	Project Manager	work: 734-779-2404 cell: [redacted]
Steve Kline	Health and Safety Coordinator (HSC)	work: 212-594-8140 cell: [redacted]
Mark Malchik	GZA Director of Health and Safety	work: 781-278-5747 Pager: [redacted]

PLAN ACKNOWLEDGMENT AND APPROVALS

Approval or Acknowledgment	SSO/CP	SS/PM	AIC/PIC	HSC
Probable hazards identified on form.	✓	✓	✓	✓
Project scope accurately reflected on form.	✓	✓	✓	✓
Appropriate emergency response information identified on form.	✓	✓	✓	✓
Appropriate control measures identified on form.	✓	✓	✓	✓
Hazards and control measures to be implemented on site acknowledged.	✓	✓	✓	✓
Overall project scope and health and safety requirements acknowledged.	✓	✓	✓	✓

DOCUMENTATION TO BE COMPLETED ON SITE

- An Entergy-issued **Site Health and Safety Briefing Sign-in Sheet** must be completed daily and prior to any on-site activities. Safety briefings will be given by a Site Supervisor or Entergy Supervisor at the start of each work day.
- A **GZA Field Activities Sheet** must be completed daily and will include information regarding field work performed and any health and safety issues, events, or concerns encountered by GZA while on-Site. One Field Activities Sheet will be filled out by GZA on-Site personnel at the end of each work day.

EQUIPMENT AND CONTROLS

Monitoring Equipment [1]	Personal Protective Equipment
☐ PID Type: ______ Lamp Energy: ______ eV	☐ Respirator Type: ______
☐ FID Type: ______	☐ Resp-Cartridge Type: ______
☐ Cal gas and equipment type: ______	☒ Hearing Protection
☐ LEL/O_2 Meter	☒ Hardhat
☒ Others: TLDs and MPGs	☐ Outer Gloves Type: ______
	☒ Inner Gloves Type: Nitrile Disposable- Hypoallergenic
Other Equipment & Gear [2]	☒ Steel-toed boots/shoes
☒ 10# ABC Fire Extinguisher when gasoline powered equipment is present	☐ Coveralls Type: ______
☐ Caution Tape	☐ Outer Boots Type: ______
☒ Traffic Cones or Stanchions	☒ Eye Protection with side shields
☒ Warning Signs or Placards	☐ Traffic Vest
☒ Decon Buckets, Brushes, Detergent, Towels and Plastic Bags	☐ Personal Flotation Device (PFD)
☐ Others:	Others: Leather or Canvas Work Gloves

1. All direct reading instruments must be referenced on site at least once/day (pre- and post-sampling) using a cal-gas reference standard and in accordance with the manufacturer's instructions. Monitoring using direct reading instruments should be continuous while there is disturbance of material (e.g. soil).

2. A 15- to 25-foot exclusion zone is required wherever necessary to control access to heavy equipment and/or hazardous exposure situations.

AIR MONITORING INSTRUMENTS AND ACTION LEVELS:

Anticipated Chemical Hazards: Radioactive materials

Organic Vapor Detector (H-Nu, OVM, OVA) – none required

_____ to _____ units	Remain in Level D. Use colorimetric tubes or other chemical specific device to verify PID readings do not contain low PEL toxic materials (Benzene, Vinyl Chloride, etc.) where applicable. Cease work and consult with DHSC if levels of benzene or vinyl chloride exceed 1/2 ppm on a sustained (5 min) basis.
_____ to _____ units	Withdraw from work area and contact Project Management. Proceed to Level C protection for re-entry, or discontinue operation
>____ units	Secure operations, withdraw from work area, and discontinue work at that location until contaminants can be evaluated, and detailed (SSHP) plan implemented.

Combustible Gas Indicator CGI/LEL Meter (if required) – none required

• < 10% LEL:	Continue to monitor with caution. Eliminate all ignition sources.
• 10% to 20% LEL:	Stop operations until appropriate vapor control measures (i e. foam, sand, polyethylene, film, portable blower etc.) and resample before resuming activity.
• > 20% LEL:	Stop operations and withdraw from area. Contact DHSC before proceeding.

HAZARD ASSESSMENT

Enter either: **X** *(applies, or required item(s) available) or* NA *(not applicable)*

HAZARD ASSESSMENT: PHYSICAL HAZARDS AND RELATED CONCERNS

☒ **Confined Space Entry (CSE).** Confined space entry means the *potentially hazardous* entry into any space which, by design, has limited openings for entry and exit, unfavorable natural ventilation which could contain or produce dangerous air contaminants, and which is not intended for continuous employee occupancy. Confined spaces include but are not limited to storage tanks, compartments of ships, process vessels, pits, silos, vats, degreasers, reaction vessels, boilers, ventilation and exhaust ducts, sewers, tunnels, underground utility vaults, and pipelines. Other environments which must be treated as confined spaces include *test pits, and basements, garages, warehouses and other indoor areas where mechanical (i.e., diesel, propane, gasoline or similarly powered) equipment must be operated for drilling or test pitting purposes.* Confined space entry should be allowed only when absolutely necessary, and then only when all requirements of GZA's Confined Space Entry Control Program, (Policy 02-8200) and/or CSE Program Supplement for Indoor Drilling (and Similar Operations) and/or Trench and Excavation Safety and Health Guide (and CSE Program Supplement), contained in the Health and Safety Program Manual, have been satisfied.

☒ **Construction Hazards, Drill Rigs, Backhoes, etc.** The use of drill rigs, backhoes and other heavy equipment represent potentially serious construction hazards. Whenever such equipment is used, personnel in the vicinity should be limited to those who must be there to complete their assigned duties. All personnel must avoid standing within the turning radius of the equipment or below any suspended load. Job sites must be kept as clean, orderly and sanitary as possible. When water is used, care must be taken to avoid creating muddy or slippery conditions. If slippery conditions are unavoidable, barriers and warning signs must be used to warn of these dangers.

Never turn your back to operating machinery. Never wear loose clothing, jewelry, hair or other personal items around rotating equipment or other equipment that could may catch or ensnare loose clothing, jewelry, hair or other personal items. Always stand far enough away from operating machinery to prevent accident contact which may result from mechanical or human error.

Additionally, the following basic personal protective measures must be observed: **Hardhats** must be worn to protect against bumps or falling objects. **Safety glasses** must be worn by all workers in the vicinity of drill rigs or other sources of flying objects. Goggles, face shields or other forms of eye protection must be worn when necessary to protect against chemicals or other hazards. **Steel-toed safety shoes or boots** are also required. The shoes must be chemically resistant or protected with appropriately selected boots/coverings where necessary. Unless otherwise specified, normal **work clothes** must be worn. Long sleeves and gloves are also required whenever necessary to protect against hazardous contact, cuts, abrasions or other possible skin hazards.

☒ **Electrical.** OSHA regulations require that employees who may be exposed to electrical equipment be trained to recognize the associated hazards and the appropriate control methods. All **extension cords** used for portable tools or other equipment must be designed for hard or extra usage and be (three-wire) grounded. All 120-volt, single-phase 15- and 20-ampere receptacle outlets on construction sites, and other locations where moisture/water contact may occur, must be equipped with **ground-fault circuit interrupters** (GFCI) units. GFCI units must be attached directly to or as close as possible to the receptacle. GFCI located away from the receptacle will not protect any wiring between the receptacle and the GFCI unit. Only the wiring plugged into the GFCI and outward will be protected by the GFCI. All (**temporary lighting**) lamps for general illumination must be protected from accidental breakage. Metal case sockets must be grounded. Portable lighting in wet or conductive locations should be 12 volts or less.

☐ **Drums and Buried Drums.** As a precautionary measure, personnel must assume that *labeled* and *unlabeled drums* encountered during field activities contain hazardous materials until their contents can be confirmed and characterized. Personnel should recognize that drums are frequently mislabeled, particularly drums that are reused.

Only trained and authorized personnel should be allowed to perform drum handling. Prior to any handling, drums must be visually inspected to gain as much information as possible about their contents. Trained field personnel must look for signs of deterioration such as corrosion, rust or leaks, and for signs that the drum is under pressure such as swelling or bulging. Drum-type and drumhead configuration may provide the observer with information about the type of material inside, (i.e., a removable lid is designed to contain solids, while the presence of a bung indicates liquid storage).

Although not usually anticipated, buried drums can be encountered when digging test pits. Therefore, the following provisions must be observed if drums are encountered. Machine excavation (i.e., backhoe) should cease immediately anytime a drum is encountered. The appropriate management personnel should be notified immediately. All GZA personnel should be instructed to immediately leave the work area.

Even authorized personnel must not enter an excavation where drums have been uncovered, even for monitoring purposes, unless all provisions of OSHA's trenching and excavation standard have been met and the appropriate level of personal protective equipment (PPE) is utilized. Sampling of unknown drums usually requires Level B protection. Buried drums must not be moved unless it can be accomplished in a safe manner and overpack drums are available.

☐ **Fire and Explosion.** The possibility of flammable materials being encountered during field activities must be recognized and the appropriate steps necessary to minimize fire and explosion must be observed. This includes situations where *organic vapors, free product or methane* are, or may be, encountered. When this occurs, monitoring with a combustible gas indicator (CGI), is required.

In situations where hexane, methanol are needed for field activities, the following precautions must be observed: keep flammable and combustible materials away from heat, sparks and open flames; do not smoke around flammable or combustible materials; provide an ABC rated fire extinguisher appropriate for the materials present, and keep all flammable and combustible liquids in approved and properly labeled safety containers.

☐ **Landfill/Methane Hazards.** Fire and explosion should be regarded as one of, if not the, most significant potential hazards associated with drilling operations and other intrusive work conducted at a landfill. Accordingly, all sources of ignition must be fully controlled. Failure to control ignition sources could result in fire, explosion and pose a serious threat to life and health. Control methods may include forced ventilation and/or filling the borehole with enough water to inhibit the release of methane and other gases which would otherwise escape through the top of the borehole.

If forced (mechanical) ventilation is to be used, all such equipment must be approved for Class I, Division I hazardous atmospheres. The blower must be positioned to blow across the top of the borehole so that gases and vapors may be diluted as they exit the borehole. Do not attempt to suck out the gases or vapors. Blowers, all other mechanical equipment, and tools which could release sparks or static electricity must be bonded and grounded.

Regardless of the gas/vapor control method used, the atmosphere surrounding the borehole must be frequently monitored using direct reading instruments approved for Class I, Division I hazardous atmospheres. Monitoring should be conducted within 1 to 2 feet of the top of the borehole. Do not insert sampling devices into the borehole. The use of tubing connected to a remote instrument is recommended. Never approach the auger or drill shaft while it is in operation. Always notify the operator when about to take a reading.

Regardless of actual instrument readings, if all sources of ignition can not be controlled, operations should be immediately shut down if readings equal or exceed 10% of LEL and the area evacuated until ignition sources have been eliminated. Ignition sources include, but are not limited to: smoking, static electricity, lighting, open flames, spontaneously ignitable substances, frictional heat or sparks, hot surfaces, radiant heat, electrical sparks, stray currents, cutting and welding, and ovens, furnaces and heating equipment.

☒ **Heat and Cold Stress.** Overexposure to temperature extremes can represent significant risks to personnel if simple precautions are not observed. Typical control measures designed to prevent **heat stress** include dressing properly, drinking plenty of the right fluids, and establishing an appropriate work/break regimen. Typical control measures designed to prevent **cold stress** also include dressing properly, and establishing an appropriate work/break regimen. The project manager must assure that the appropriate provisions of **GZA's Heat and Cold Stress Control Program** contained in the Health and Safety Program Manual are observed.

☒ **Moving Vehicles, Traffic Safety.** All vehicular traffic routes which could impact worker safety must be identified and communicated. Whenever necessary, barriers or other methods must be established to prevent injury from moving vehicles. Traffic vests must be worn by personnel working near moving vehicular traffic. This is particularly important when field activities are conducted in parking lots, driveways, ramps or roadways. OSHA 1926.201 specifies that when signs, signals or barricades do not provide adequate protection from highway or street traffic, flagmen must be utilized. *Flagmen must wear red or orange garments. Garments worn at night must be reflective.*

☒ **Noise.** Noise exposure can be affected by many factors including the number and types of noise sources (continuous vs. intermittent or impact), and the proximity to noise intensifying structures such as walls or buildings which cause noise to bounce back or echo. The single most important factor effecting total noise exposure is distance from the source. The closer one is to the source the louder the noise. The operation of a drill rig, backhoe or other mechanical equipment can be sources of significant noise exposure. In order to reduce the exposure to this noise, personnel working in areas of excessive noise must use hearing protectors (ear plugs or ear muffs) in accordance with the **GZA Hearing Conservation Program** contained in the Health and Safety Program Manual.

Rule-of-Thumb: Wherever actual data from sound level meters or noise dosimeters is unavailable and it is necessary to raise one's voice above a normal conversational level to communicate with others within 3 to 5 feet away, hearing protection should be worn.

☒ **Overhead Utilities and Hazards.** Overhead hazards can include low hanging structures which can cause injury due to bumping into them. Other overhead hazards include *falling objects, suspended loads, swinging loads and rotating equipment*. Hardhats must be worn by personnel in areas were these types of physical hazards may be encountered. Barriers or other methods must also be used to exclude personnel from these areas were appropriate. Electrical wires are another significant overhead hazard. According to OSHA (29 CFR 1926.550), *the minimum clearance which must be maintained from overhead electrical wires is 10 feet* from an electrical source rated ≤ 50 kV. Sources rated > 50 kV require a minimum clearance of 10 feet plus 0.4 inch per kV above 50 kV.

☐ **Pedestrian Traffic.** The uncontrolled presence of pedestrians on a drilling or excavation site can be hazardous to both pedestrians and site workers. Prior to the initiation of site activities, the site should be surveyed to determine if, when and where pedestrian may gain access. This includes walkways, parking lots, gates and doorways. Barriers or caution tape should be used to exclude all pedestrian traffic. *Exclusion of pedestrian traffic is intended to prevent injury to the pedestrians and eliminate distractions which could cause injury to GZA personnel or other site workers.*

☐ **Test Pit and/or other Excavations.** All provisions of the OSHA trenching and excavation standard (29 CFR 1926.650-652) and GZA's **Trench and Excavation Safety and Health Guide (and CSE Program Supplement)** contained in the Health and Safety Manual must be followed during excavation activities. This includes *all test pit excavation and sampling activities.* The estimated location of utility installations, such as sewer, telephone, electric, water lines and other underground installations that may reasonably be expected to be encountered during excavation work, must be determined prior to opening an excavation.

Excavations in contaminated or potentially contaminated areas must be tested for confined spaces atmospheric hazards prior to entry. Excavations should not be entered if other means are available to perform the task requiring entry. If entry into an excavation is required, the atmosphere within the space must be monitored by a trained person to assure that oxygen concentrations are at greater than or equal to 19.5 percent, that combustible gas levels are less than 10 percent, and that vapor levels are within applicable safe exposure (PEL and TLV) limits.

A ladder or similar means of egress must be located in excavations greater than 4 feet in depth so as to require no more than 25 feet of lateral travel for employees. *No person should be allowed to enter an excavation in type B or C soil greater than 5 feet in depth unless the walls of the excavation have been protected using an approved shield (trench box), an approved shoring system, or the walls have been sloped back to an angle of 34 degrees, the excavation is free of accumulated water, and the excavation has been tested for hazardous atmospheres* as noted previously. If personnel enter an excavation, the spoils pile and all materials must be placed at least 2 feet from the edge of the excavation to prevent the materials from rolling into the excavation. *Personnel must remain at least 2 feet away from the edge of the excavation at all times.* Upon completion of a test pit exploration, the excavation should be backfilled and graded. Excavation should never be left open unless absolutely necessary, and then only with proper barricading and controls to prevent accidental injury.

☐ **Underground Utilities and Hazards.** The identification of underground storage tanks (USTs), pipes, utilities and other underground hazards is critically important prior to all drilling, excavating and other intrusive activities. In accordance with OSHA 29 CFR 1926.650, *the estimated location of utility installations, such as sewer, telephone, electric, water lines and other underground installations that may reasonably be expected to be encountered* during excavation work, *must be determined* prior to opening an excavation. The same requirements apply to drilling operations and the use of soil-gas probes. Where public utilities may exist, the utility agencies or operators must be contacted directly or through a utility-sponsored service such as *Dig-Safe*. Where other underground hazards may exist, reasonable attempts must be made to identify their locations as well. *Failure to identify underground hazards can lead to fire, explosion, flooding, electrocution or other life threatening accidents.*

☒ **Water Hazards and Boat Sampling.** The collection of water or sediment samples on or immediately adjacent to a body of water can pose significant hazards. In addition to the slip, trip and fall hazards associated with wet surfaces, the potential for drowning accidents must be recognized. These hazards can be intensified by the use of some personnel protective equipment (PPE), particularly if respiratory protection is worn. OSHA 29 CFR 1926.106 requires that all employees working over or near water, where the danger of drowning exists, *must wear a U.S. Coast Guard-approved life jacket or buoyant work vest.* Ring buoys and emergency *standby personnel* must also be in place.

HAZARD ASSESSMENT: CHEMICAL HAZARDS AND RELATED CONCERNS

☒ **Chemicals Subject to OSHA Hazard Communication.** All chemicals used in field activities such as solvents, reagents, decontamination solutions, or any other hazardous chemical must be listed and accompanied by the required labels, Material Safety Data Sheets (MSDS), and employee training documentation (OSHA 1910.1200). For additional information refer to **GZA's Hazard Communication Program** contained in the Health and Safety Program manual.

☐ **Asbestos.** Disturbance of building materials in buildings built prior to 1980 must be evaluated for the presence of asbestos-containing materials by an accredited GZA inspector. The inspection and/or removal of asbestos-based or asbestos-containing building materials is regulated by some major cities and several states. Regulations require individuals who conduct building inspections for the presence of asbestos or collect samples of asbestos containing materials to be licensed or certified. GZA employees must determine the applicability of these regulations prior to any activities involving asbestos. The primary health effects of asbestos exposure include asbestosis (a scarring of the lungs), lung cancer, mesothelioma and other forms of cancer. Exposure to asbestos is regulated by a comprehensive OSHA standard (29 CFR 1910.1001).

☐ **BTEX Compounds.** Exposure to the vapors of **benzene, ethyl benzene, toluene** and **xylenes** above their respective permissible exposure limits (PELs), as defined by the Occupational Safety and Health Administration (OSHA), may produce irritation of the mucous membranes of the upper respiratory tract, nose and mouth. Overexposure may also result in the depression of the central nervous system. Symptoms of such exposure include drowsiness, headache, fatigue and drunken-like behavior. Benzene has been determined to be carcinogenic, targeting blood-forming organs and bone marrow. The odor threshold for benzene is higher than the PEL and employees may be overexposed to benzene without sensing its presence, therefore, detector tubes must be utilized to evaluate airborne concentrations.

The vapor pressures of these compounds are high enough to generate significant quantities of airborne vapor. On sites where high concentrations of these compounds are present, a potential inhalation hazard to the field team during subsurface investigations can result. However, if the site is open and the anticipated quantities of BTEX contamination are small (i.e., part per million concentrations in the soil or groundwater), overexposure potential will also be small.

☐ **Carbon Monoxide.** Carbon monoxide (CO) is a gas usually formed by the incomplete combustion of various fuels. Welding, cutting and the operation internal combustion engines can produce significant quantities of CO. Amounts of CO can quickly rise to hazardous levels in poorly ventilated areas. CO is odorless and colorless. It cannot be detected without appropriate monitoring equipment. LEL/O_2 meters and H-Nu/photoionizing detectors are not appropriate for the detection of CO. A direct reading instrument, calibrated for CO, should be used. Common symptoms of overexposure include pounding of the heart, a dull headache, flashes before the eyes, dizziness, ringing in the ears and nausea. These symptoms must not be relied upon in place of an appropriately calibrated monitoring instrument. Exposures should not exceed 15 ppm. Exposures above 15 ppm require the use of supplied air respirators. Air purifying respirators are not approved for protection against CO.

☐ **Chlorinated Organic Compounds.** Exposure to the vapors of many chlorinated organic compounds such as vinyl chloride, tetrachloroethylene, 1,1,1-trichloroethane, trichloroethylene and 1,2-dichloroethylene above their respective permissible exposure limits (PELs) will result in similar symptoms. The actual PELs as set by the Occupational Safety and Health Administration (OSHA) vary depending on the specific compound. Overexposure to the vapor of these compounds can cause irritation of the eyes, nose and throat. The liquid if splashed in the eyes, may cause burning irritation and damage. Repeated or prolonged skin contact with the liquid may cause dermatitis. Acute overexposure to chlorinated hydrocarbons depresses the central nervous system exhibiting such symptoms as drowsiness, dizziness, headache, blurred vision, uncoordination, mental confusion, flushed skin, tremors, nausea, vomiting, fatigue and cardiac arrhythmia. Alcohol may make symptoms of overexposure worse. If alcohol has been consumed, the overexposed worker may become flushed. Some of these compounds are considered to be potential human carcinogens. Exposure to *vinyl chloride* is regulated by a comprehensive OSHA standard (29 CFR 1910.1017).

☐ **Chromium Compounds.** Hexavalent chromium compounds, upon contact with the skin can cause ulceration and possibly an allergic reaction. Inhalation of hexavalent chromium dusts is irritating and corrosive to the mucous membranes of the upper respiratory tract. Chrome ulcers and chrome dermatitis are common occupational health effects from prolonged and repeated exposure to hexavalent chromium compounds. Acute exposures to hexavalent chromium dusts may cause coughing or wheezing, pain on deep inspiration, tearing, inflammation of the conjunctiva, nasal itch and soreness or ulceration of the nasal septum. Certain forms of hexavalent chromium have been found to cause increased respiratory cancer among workers.

Trivalent chromium compounds (chromic oxide) are generally considered to be of lower toxicity, although dermatitis may occur as a result of direct handling.

☒ **Fuel Oil.** See Petroleum Hydrocarbons (PHC)

☒ **Gasoline.** See BTEX Compounds, and Tetraethyl and Tetramethyl Lead.

☐ **Herbicides.** Some of the commonly used herbicides present a low toxicity to man. However, other herbicides pose more serious problems. Organophosphorus and carbamate herbicides, if inhaled or ingested can interfere with the functioning of the central nervous system. Many herbicides can be readily absorbed through the skin to cause systemic effects. In addition to being absorbed through the skin, many herbicides, upon contact with the skin, may cause discoloring, skin irritation or dermatitis. Contaminants of commercial preparations of chlorinated phenoxy herbicides such as 2,4,5-T include 2,3,7,8-tetrachlorodibenzo-p-dioxin (dioxin). Dioxin is a known mutagen and a suspect carcinogen.

☐ **Hydrogen Sulfide (H_2S).** Hydrogen sulfide, characterized by its "rotten egg" odor, is produced by the decomposition of sulfur-containing organic matter. It is found in many of the same areas where methane is found such as landfills, swamps, sewers and sewer treatment facilities. An important characteristic of H_2S is its ability to cause a decrease in ones ability to detect its presence by smell. So although one may no longer be able to smell it, it could still be present in harmful concentrations.

The symptoms of over exposure include headache, dizziness, staggering and nausea. Severe over exposure can cause respiratory failure, coma, and death. The current OSHA PEL is 10 ppm as an 8-hour TWA. The ACGIH TLV is the same.

☐ **Lead Paint.** The inspection and/or removal, sanding, grinding, etc. of lead-based or lead-containing paints is now strictly regulated by OSHA. States may require individuals who conduct lead paint inspections or collect samples of lead paint to be licensed or certified. GZA employees must determine the applicability of these regulations prior to any activities involving lead paint. For additional health information, see Metal Compounds.

☐ **Metal Compounds.** Overexposure to metal compounds has been associated with a variety of local and systemic health hazards, both acute and chronic in nature, with chronic effects being most significant. Direct contact with the dusts of some metal compounds can result in contact or allergic dermatitis. Repeated contact with arsenic compounds may result in hyperpigmentation. Cases of skin cancer due to the trivalent inorganic arsenic compounds have been documented. The moist mucous membranes, particularly the conjunctivae, are most sensitive to the irritating effects of arsenic. Copper particles embedded in the eye result in a pronounced foreign body reaction with a characteristic discoloration of eye tissue.

Inhalation of copper and zinc dusts and fumes above their established PELs may result in flu-like symptoms known as "metal fume fever." Prolonged and repeated inhalation of the dusts of inorganic arsenic compounds above the established PEL may result in weakness, loss of appetite, a sense of heaviness in the stomach and vomiting. Respiratory problems such as cough, hoarseness and chest pain usually precede the gastrointestinal problems. Chronic overexposure to the dusts of inorganic arsenic may result in lung cancer.

The early symptoms of lead poisoning are usually nonspecific. Symptoms include sleep disturbances, decreased physical fitness, headache, decreased appetite and abdominal pains. Chronic overexposure may result in severe colic and severe abdominal cramping. The central nervous system (CNS) may also be adversely effected when lead is either inhaled or ingested in large quantities for extended periods of time. The peripheral nerve is usually affected. "Wrist drop" is peculiar to such CNS damage. Lead has also been characterized as a male and female reproductive toxin as well as a fetotoxin. Exposure to lead (Pb) is regulated by a comprehensive OSHA standard (29 CFR 1910.1025).

☐ **Methane.** Methane is an odorless, colorless, tasteless, gas that cannot be detected by an H-Nu or similar photoionizing detector (PID). When present in high concentrations in air, methane acts primarily as a simple asphyxiant without other significant physiologic effects. Simple asphyxiants dilute or displace oxygen below that required to maintain blood levels sufficient for normal tissue respiration.

Methane has a lower explosive limit (LEL) of 5 percent and an upper explosive limit (UEL) of 15 percent. The LEL of a substance is the minimum concentration of gas or vapor in air below which the substance will not burn when exposed to a source of ignition. This concentration is expressed in percent by volume. Below this concentration, the mixture is "too lean" to burn or explode. The UEL of a substance is the maximum concentration of gas or vapor in air above which the substance will not burn when exposed to a source of ignition. Above this concentration, the mixture is "too rich" to burn or explode. The explosive range is the range of concentrations between the LEL and UEL where the gas-air mixture will support combustion. For methane this range is 5 to 15 percent.

☐ **Pesticides.** Pesticides can be grouped into three major categories: organophosphates, carbamate and chlorinated hydrocarbons. The actual permissible exposure limits (PELs) as set by the Occupational Safety and Health Administration (OSHA), vary depending on the specific compound. Organophosphates, including Diazinon, Malathion and Parathion, are quickly absorbed into the body by inhalation, ingestion and direct skin contact. The symptoms of exposure include headache, fatigue, dizziness, blurred vision, sweating, cramps, nausea and vomiting. More severe symptoms can include tightness of the chest, muscle spasms, seizures and unconsciousness. It should also be noted that the Malathion and Parathion PELs both carry the *Skin* notation, indicating that these compounds adversely effect or penetrate the skin. OSHA specifies that skin exposure to substances carrying this designation be prevent or reduced through the use of the appropriate personal protective equipment (PPE).

Chlorinated Hydrocarbons such as Chlordane, DDT and Heptachlor can cause dizziness, nausea, abdominal pain and vomiting. The more severe symptoms include epileptic like seizures, rapid heart beat, coma and death. These compounds also carry the OSHA *Skin* notation. The symptoms of exposure to carbamate such Carbaryl (also known as Sevin) are similar to those described for the organophosphates. However, the OSHA exposure limit for Carbaryl *does not* carry the Skin notation.

☒ **Petroleum Hydrocarbons (PHCs).** Petroleum Hydrocarbons such as fuel oil are generally considered to be of low toxicity. Recommended airborne exposure limits have not been established for these vapors. However, inhalation of low concentrations of the vapor may cause mucous membrane irritation. Inhalation of high concentrations of the vapor may cause pulmonary edema. Repeated or prolonged direct skin contact with the oil may produce skin irritation as a result of defatting. Protective measures, such as the wearing of chemically resistant gloves, to minimize contact are addressed elsewhere in this plan. Because of the relatively low vapor pressures associated with PHCs, an inhalation hazard in the outdoor environment is not likely.

☒ **Polychlorinated Biphenyls (PCBs).** Prolonged skin contact with PCBs may cause the formation of comedones, sebaceous cysts, and/or pustules (a condition known as chloracne). PCBs are considered to be suspect carcinogens and may also cause reproductive damage.

The OSHA permissible exposure limits (PELs) for PCBs are as follows:

Compound	*PEL (8-hour time-weighted average)*
Chlorodiphenyl (42% Chlorine)	1 mg/m^3-Skin
Chlorodiphenyl (54% Chlorine)	0.5 mg/m^3 -Skin

It should be noted that PCBs have extremely low vapor pressures (0.001 mm Hg @ 42% Chlorine and 0.00006 mm Hg @ 54% Chlorine). This makes it unlikely that any significant vapor concentration (i.e., exposures above the OSHA PEL) will be created in the ambient environment. This minimizes the potential for any health hazards to arise due to inhalation unless the source is heated or generates an airborne mist. If generated, vapor or mists above the PEL may cause irritation of the eyes, nose, and throat. The exposure limits noted above are considered low enough to prevent systemic effects but it is not known if these levels will prevent local effects. It should also be noted that both PELs carry the *Skin* notation, indicating that these compounds adversely effect or penetrate the skin. OSHA specifies that skin exposure to substances carrying this designation be prevented or reduced through the use of the appropriate personal protective equipment (PPE).

☐ **Polycyclic Aromatic Hydrocarbons (PAHs).** Due to the relatively low vapor pressure of PAH compounds, vapor hazards at ambient temperatures are not expected to occur. However, if site conditions are dry, the generation of contaminated dusts may pose a potential inhalation hazard. Therefore dust levels should be controlled with wetting if necessary. Repeated contact with certain PAH compounds has been associated with the development of skin cancer. Contact of PAH compounds with the skin may cause photosensitization of the skin, producing skin burns after subsequent exposure to ultraviolet radiation. Protective measures, such as the wearing of chemically resistant gloves, are appropriate when handling PAH contaminated materials.

☒ **Radioactive Hazards.** Radioactive materials represent a potentially serious exposure hazard, depending on the nature and concentration of the radioactive isotope. In order to assess the hazards, obtain information about the elemental identity of the radioactive material (e.g. uranium, etc.), the radioactive form or "isotope" (e.g. uranium 234 vs. uranium 235 vs. uranium 238), the concentration or "activity" of radiation in the media to be encountered, and also determine the type of radioactive emissions released from the particular material (e.g., Is the material an alpha, beta or gamma emitter, or combination thereof?). Alpha and beta emissions are particulate in nature and have little or no capability to penetrate even very thin solid materials....so as long as alpha and beta emitters remain outside the body, the radioactive particles emitted have little or no ability to penetrate the skin's exterior layer of dead cells...therefore little or no energy is deposited in living tissue and essentially no cellular damage will occur. On the other hand, alpha and beta emitters can be particularly dangerous if inhaled or ingested, since all of the energy of the material's particulate emissions is deposited in living tissue within the body, potentially causing cell damage. Gamma radiation (which includes x-rays) can generally pass through the body, thus resulting in little or no difference in absorbed dose whether the material is inhaled or ingested into the body, or if it remains outside the body. With all radioactive materials, the actual dose is dependent on the concentration/activity of radioactivity and on the inherent energy of the emissions. In addition to the use of various types of personal protective equipment, monitoring of exposures through the use of direct reading meters or dosimeters may be warranted. Consult with your H&S Coordinator for information about proper health and safety measures.

☐ **Tetraethyl and Tetramethyl Lead.** Both compounds are used as anti-knock ingredients in gasoline. The inhalation of tetraethyl lead dusts may result in irritation of the respiratory tract. This dust, when in contact with moist skin or eye membranes, may cause itching, burning and transient redness.

The direct absorption of a sufficient quantity of tetraethyl lead, whether briefly at a high rate, or for prolonged periods at a low rate, may cause acute intoxication of the central nervous system. Mild degrees of intoxication may cause headache, anxiety, insomnia, nervous excitation and minor gastrointestinal disturbances.

☐ **Volatile Organic Compounds (VOCs).** See BTEX compounds and Chlorinated Organic Compounds.

☐ **Waste Oil.** See Petroleum Hydrocarbons (PHCs) and Cutting Oil.

HAZARD ASSESSMENT: BIOLOGICAL HAZARDS AND RELATED CONCERNS

☒ **Insects.** Insects represent significant sources (vectors) of disease transmission. Therefore, precautions to avoid or minimize potential contact should be considered prior to all field activities. Disease or harmful effects can be transmitted through bites, stings or through direct contact with insects or through ingestion of foods contaminated by certain insects. Examples of disease transmitted by insect bites include encephalitis and malaria from contaminated mosquitoes, Lyme disease and spotted fever from contaminated ticks. Stinging insects, such as bees and wasps, are prevalent throughout the country, particularly during the warmer months. The stings of these insects can be painful, and cause serious allergic reactions to some individuals.

☒ **Lyme Disease.** Lyme disease is an infection caused by the bite of certain ticks, primarily deer, dog and wood ticks. The symptoms of Lyme disease usually start out as a skin rash then progress to more serious symptoms. The more serious symptoms can include lesions, headaches, arthritis and permanent damage to the neurological system. If detected early the disease can be treated successfully with antibiotics. The following steps are recommended for prevention of Lyme disease and other diseases transmitted by ticks: a) Beware of tall grass, bushes, woods and other areas where ticks may live; b) *Wear good shoes, long pants tucked into socks, a shirt with a snug collar, good cuffs around the wrists and tails tucked into the pants. Insect/tick repellents may also be useful*; c) *Carefully monitor for the presence of ticks. Carefully inspect clothes and skin when undressing. If a tick is attached to the skin it should be removed with fine tipped tweezers. You should be alert for early symptoms over the next month or so. If you suspect that you have been bitten by a tick you should contact a physician for medical advice.*

☐ **Medical Wastes and Bloodborne Diseases.** Any field activity where exposure to medical wastes or other sources of bloodborne pathogens, <u>including first aid</u>, can be reasonably anticipated must be conducted in accordance with the OSHA (29 CFR 1910.1030) *Bloodborne Pathogens* standard. According to the OSHA definition, Bloodborne Pathogens means pathogenic microorganisms that are present in human blood and can cause disease in humans. These pathogens include but are not limited to *hepatitis B virus (HBV) and human immunodeficiency virus (HIV)*. Wherever there is a potential for employee skin, eye, mucous membrane, or parenteral (skin or membrane piercing) contact with blood or other potentially infectious sources, *employees must refer to the GZA Written Exposure Control Plan.*

☐ **Poisonous Plants.** The possible presence of poisonous plants should be anticipated for field activities in wooded or heavily vegetated areas. *Poison ivy* is a climbing plant with alternate green to red leaves (arranged in threes) and white berries. *Poison oak* is similar to poison ivy and *sumac* but its leaves are oak-like in form. The leaves of these poisonous plants produce an irritating oil which causes an intensely itching skin rash and characteristic blister-like lesions. Contact with these plants should be avoided.

☒ **Rats, Snakes and Other Vermin.** Certain animals, particularly those that feed on garbage and other wastes, can represent significant sources (vectors) of disease transmission. Therefore, precautions to avoid or minimize potential contact with (biting) animals (such as rats) or animal waste (such as pigeon droppings) should be considered prior to all field activities. Rats, snakes and other wild animals can inflict painful bites. The bites can poisonous (as in the case of some snakes), or disease causing (as in the case of rabid animals). Avoidance of these animals is the best protection.

☒ **Waste Water and Sewage.** Sewage and waste water contaminated with raw, untreated sewage can represent significant sources of bacterial, viral or fungal contamination. Adverse effects, due to contact, can range from mild skin reactions or rashes to life threatening diseases. Diseases are easily transmitted by accidental ingestion or through skin contact, particularly if the skin is broken. Avoidance of direct contact and good personal hygiene are the best protection from these hazards.

MISCELLANEOUS SITE CONTROL PROCEDURES

PLAN SIGN-OFF

(Please sign and date.)

SSO/CP: [signature] 6/29/07 SS/PM: [signature] 6/29/07

AIC/PIC: [signature] HSC: [signature]

Attachments: Attachment A Incident Report and/or Discovery of a Potential Hazard

Attach additional information if required. (Revised January 2001)

Attachment A
Incident Report and/or Discovery Of A Potential Hazard

CHECK ALL THAT APPLY: ______Hazard Identified ______Injury/Illness ______Property Damage

Project Name: IPEC Long Term Monitoring Program Project #: 41.0161619.00 Today's Date:______________

Date and Time Incident Occurred: ____________________ Site Supervisor's Name: ____________________

1) Describe the incident or potential hazard:____

____

____

2) Machine or tools nvolved:____

3)Names of employees involved in incident:____

4)What personal protective was being worn when incident occurred?____________________

5) Please answer the following four questions. For responses marked yes, please elaborate on the lines below.

Was anyone injured? ___Yes ___No Was first aid administered? ___Yes ___No

Was medical treatment sought? ___Yes ___No Was there property damage? ___Yes ___No

____

____

6) What steps were taken to prevent a reoccurence?________________________________

____

____

7) What changes in process, procedure, or equipment would you recommend? ____________________

____

8) If the report is for an existing or potential hazard, has the entity controlling the hazard or potential hazard bee notified in writing? _____Yes _____No

9) Additional comments____

____

Name and signature of person preparing this form________________________________

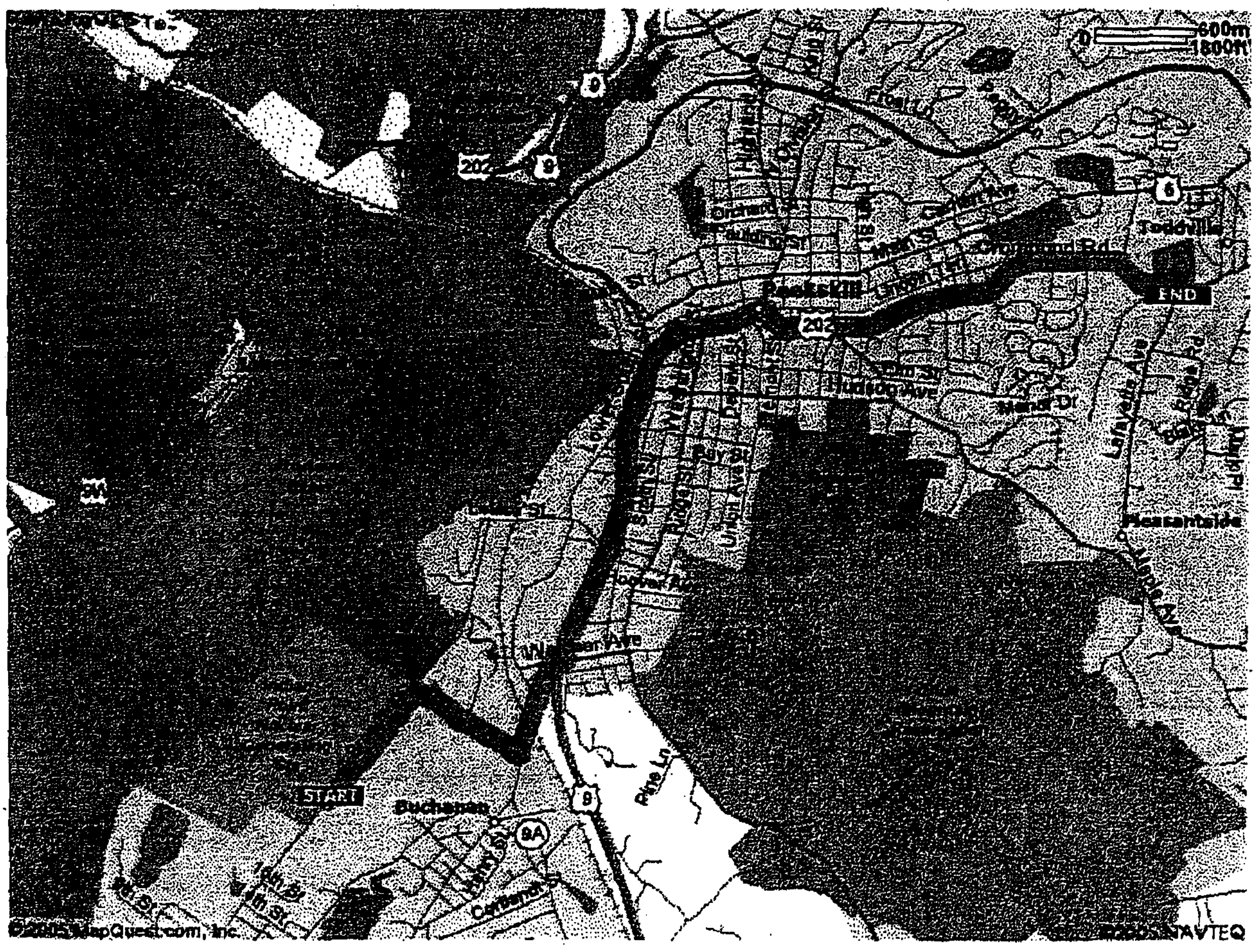
Branch Office Manager:
Corporate Director of Health and Safety:

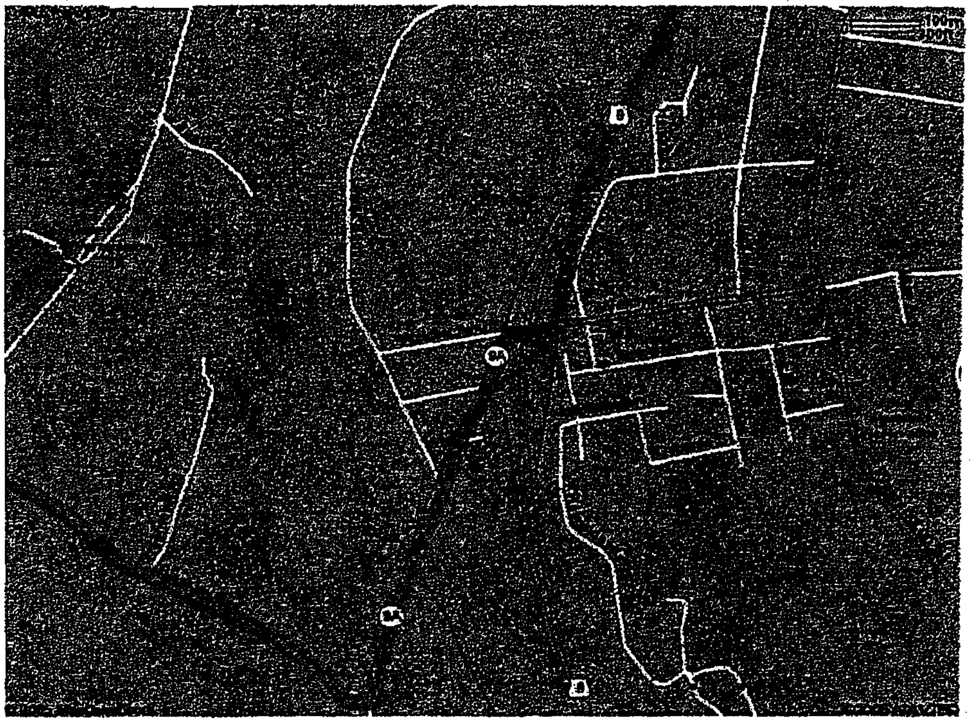
Health and Safety Coordinator:
Other:

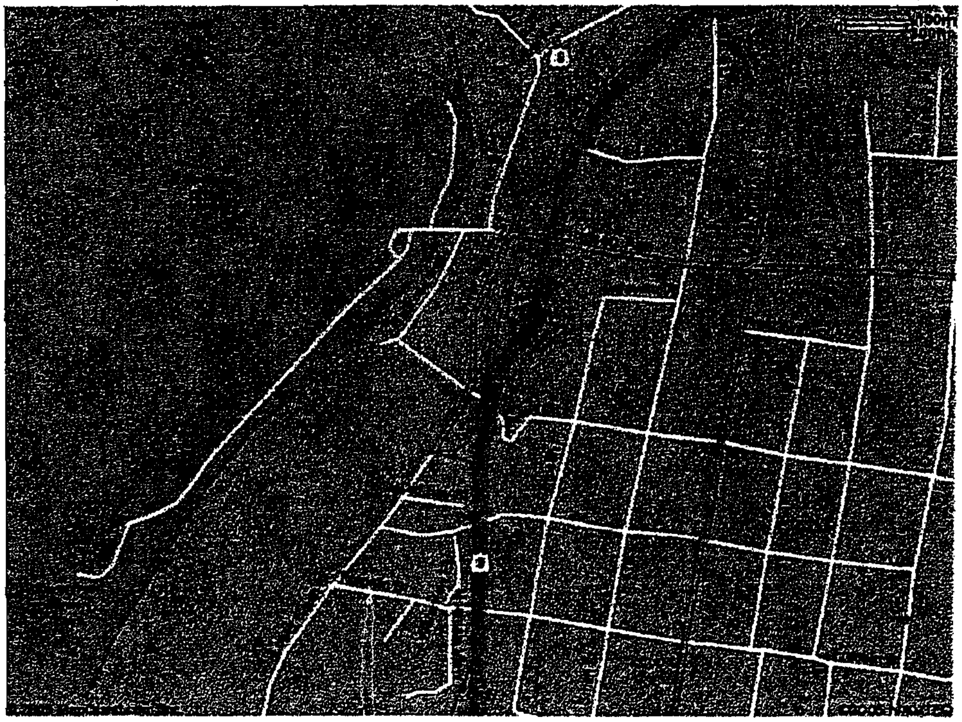
Nearby Hospital Map and Directions

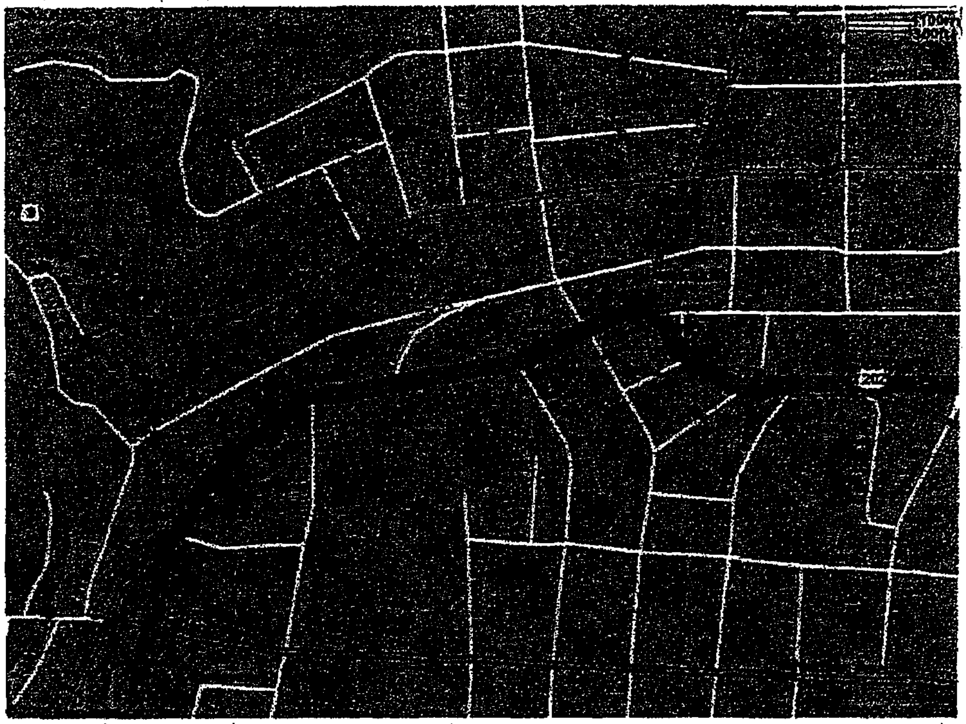
Hudson Valley Hospital Center
1980 Crompdon Rd,
Cortland Manor, NY 10567
(914) 737 - 9000

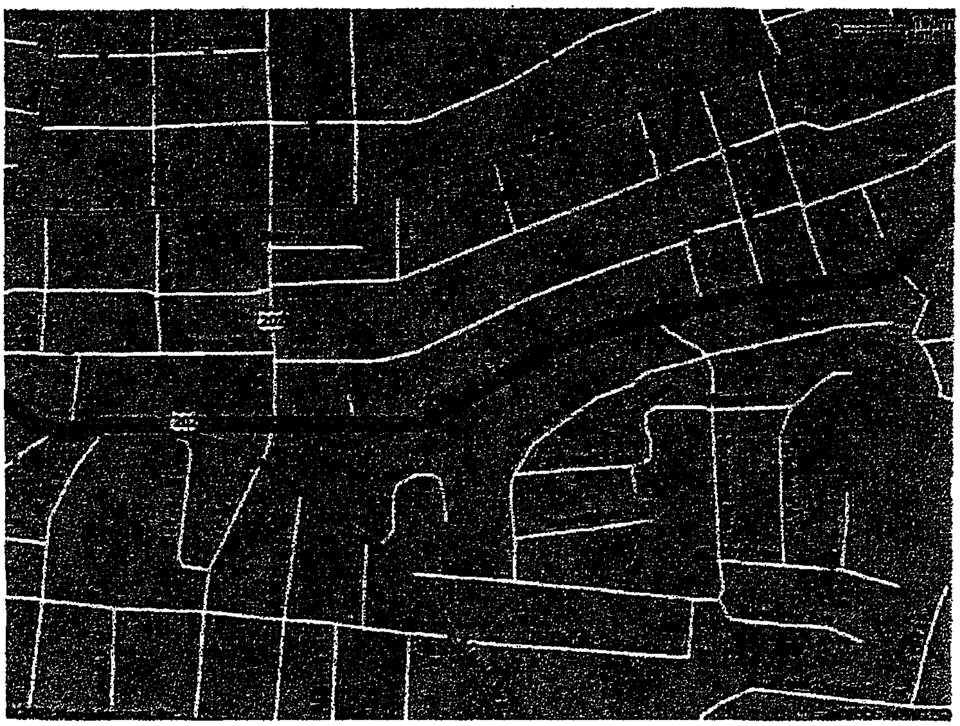
1. Head Northeast on Broadway toward Bleakley Ave.
2. Turn right on Bleakley Ave.
3. Turn left on NY-9A / New York Post Rd / Albany Post Rd.
4. Turn right on Welcher Ave / CR-92.
5. Merge onto US-9 N / Briafcliff-Peekskill Pkwy via the ramp on the left.
6. Merge onto South Street toward Hudson Ave.
7. Turn right onto S. Division St / US-202 / NY-35 / CR-24. Continue to follow CR-24.

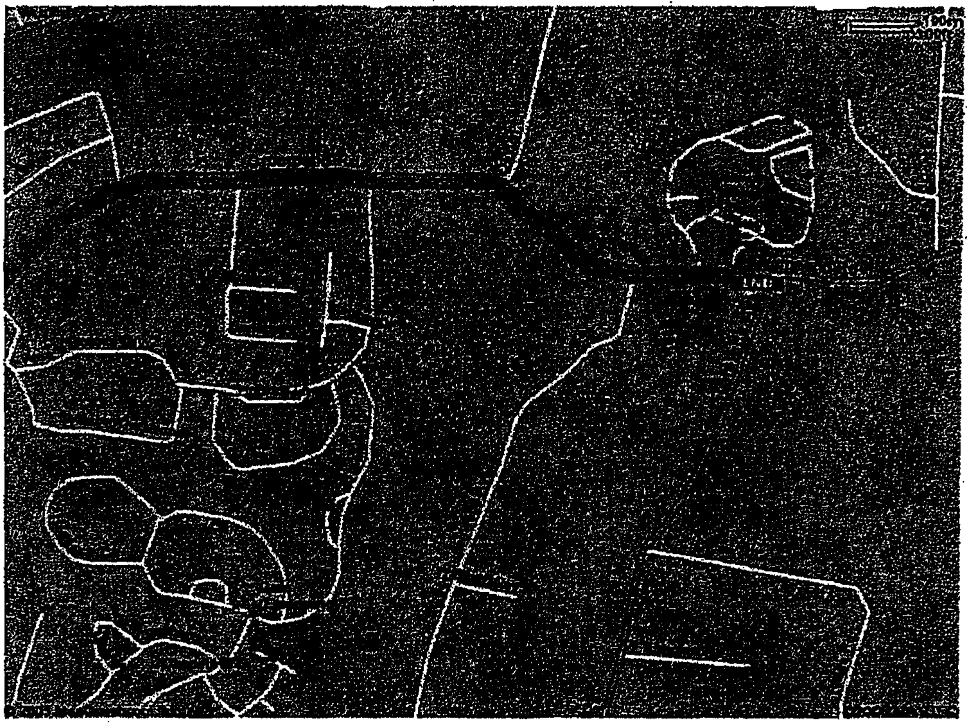












APPENDIX B

INDIAN POINT ENERGY CENTER
LONG TERM MONITORING PROGRAM
QUALITY ASSURANCE PLAN

Sampling Methods and Pumping Equipment

WELL ID	SAMPLING METHOD	PUMPING EQUIPMENT
MW30	Low Flow	Waterloo Multilevel System
MW31	Low Flow	Waterloo Multilevel System
MW32	Low Flow	Waterloo Multilevel System
MW33	Low Flow	Peristaltic Pump
MW35	Low Flow	Peristaltic Pump
MW36-24	Low Flow	Peristaltic Pump
MW36-52	Modified Traditional	Peristaltic Pump
MW37-22	Low Flow	Peristaltic Pump
MW37-32	Low Flow	Peristaltic Pump
MW37-40	Modified Traditional	Peristaltic Pump
MW37-57	Modified Traditional	Peristaltic Pump
MW38	Low Flow	Peristaltic Pump
MW39	Low Flow	Waterloo Multilevel System
MW40	Low Flow	Waterloo Multilevel System
MW41-40	Low Flow	Peristaltic Pump
MW41-63	Modified Traditional	Waterra Pump & Footvalve
MW42-49	Low Flow	Submersible Pump
MW42-78	Modified Traditional	Waterra Pump & Footvalve
MW43-28	Low Flow	Peristaltic Pump
MW43-62	Low Flow	Peristaltic Pump
MW44-63	Low Flow	Submersible Pump
MW44-102	Modified Traditional	Waterra Pump & Footvalve
MW45-42	Modified Traditional	Submersible Pump
MW45-61	Modified Traditional	Waterra Pump & Footvalve
MW46	Low Flow	Peristaltic Pump
MW47-56	Low Flow	Submersible Pump
MW47-80	Modified Traditional	Waterra Pump & Footvalve
MW48-23	Low Flow	Peristaltic Pump
MW48-37	Low Flow	Peristaltic Pump
MW49-25	Low Flow	Peristaltic Pump
MW49-42	Low Flow	Peristaltic Pump
MW49-65	Low Flow	Peristaltic Pump
MW50-42	Low Flow	Peristaltic Pump
MW50-66	Low Flow	Peristaltic Pump
MW51	Low Flow	Waterloo Multilevel System
MW52	Low Flow	Waterloo Multilevel System
MW52-12	Modified Traditional	Peristaltic Pump
MW53-82	Low Flow	Submersible Pump
MW53-120	Modified Traditional	Waterra Pump & Footvalve
MW54	Low Flow	Waterloo Multilevel System
MW55-24	Low Flow	Peristaltic Pump
MW55-35	Low Flow	Peristaltic Pump
MW55-54	Low Flow	Peristaltic Pump
MW56-53	Low Flow	Submersible Pump
MW56-83	Modified Traditional	Waterra Pump & Footvalve
MW57-11	Low Flow	Peristaltic Pump
MW57-20	Low Flow	Peristaltic Pump
MW57-45	Low Flow	Peristaltic Pump
MW58-26	Low Flow	Peristaltic Pump

Sampling Methods and Pumping Equipment (continued)

WELL ID	SAMPLING METHOD	PUMPING EQUIPMENT
MW58-65	Low Flow	Peristaltic Pump
MW59-32	Low Flow	Peristaltic Pump
MW59-45	Low Flow	Peristaltic Pump
MW59-68	Low Flow	Peristaltic Pump
MW60	Low Flow	Waterloo Multilevel System
MW62	Low Flow	Waterloo Multilevel System
MW63	Low Flow	Waterloo Multilevel System
MW66-21	Low Flow	Peristaltic Pump
MW66-36	Low Flow	Peristaltic Pump
MW67	Low Flow	Waterloo Multilevel System
MW107	Low Flow	Submersible Pump
MW111	Low Flow	Peristaltic Pump
U1CSS	Modified Traditional	Peristaltic Pump
U3T1	Low Flow	Peristaltic Pump
U3T2	Low Flow	Peristaltic Pump

APPENDIX C

Entergy
Indian Point Energy Center
450 Broadway, Suite 1
Buchanan, NY 10511

CHAIN OF CUSTODY

Client: Entergy, Indian Point Energy Center
Project: Ground Water Project
Sampled by:
Client Contact: **Phone:**

Sample Description:						Analysis / Method																						
Sample Location	Date Completed	Time Completed	Sample Matrix	Composite or Grab	No. of Containers	Gross Alpha	Gross Beta	Ni-59	Ni-63	Fe-55	Gamma	Tritium	I-129	P-32	C-14	Ce-144	Am-241	Np-237	Nb-94	Pu-238, 239/240	Pu-241	Ra-224, 226	Sr-89/90	Tc-99	U-234, 235, 238	Th-230, 232	Cs-137	Other
																							X	X				

Relinquished by:	Date:	Time:	Received by:	Date:	Time:
Relinquished by:	Date:	Time:	Received by:	Date:	Time:
Relinquished by:	Date:	Time:	Received by:	Date:	Time:
Shipment Method:			AirBill Number:		

Turnaround Time Required: ____________

Routine: ____________

Rush: ____________

Cooler Temp: ____________

Comments:

PAGE ____ OF ____

NRC FORM 303 (4-2004)

U.S. NUCLEAR REGULATORY COMMISSION

REQUEST FOR ANALYSIS AND CHAIN OF CUSTODY

LABORATORY – ORISE

LABORATORY USE ONLY

CONTROL NUMBER

SAMPLE LOCATION (LICENSEE)

LICENSE NO.	DOCKET NO.

SAMPLE SUBMITTED

# TOTAL	TYPE	VOLUME	WEIGHT

DATE SAMPLES SUBMITTED

PRIORITY
- ☐ ROUTINE
- ☐ URGENT

SAMPLE COLLECTION INTERVAL

	MONTH	DAY	YEAR	TIME
START				
STOP				

INSPECTOR RESPONSIBLE

TELEPHONE NUMBER

ANALYSIS TO BE PERFORMED	LIST DESIRED LLD *(Optional)*	OTHER TYPE OF ANALYSIS *(Specify)*	LIST DESIRED LLD *(Optional)*
☐ GROSS ALPHA (GA)		☐	
☐ GROSS BETA (GB)		☐	
☐ GAMMA SPEC (GS)		☐	
☐ TRITIUM (H3)		☐	
☐ CARBON-14 (C14)		☐	
☐ IODINE-125 (I125)		☐	

RELINQUISHED BY	RECEIVED BY	DATE	TIME	REASON FOR CHANGE OF CUSTODY

FEE RECOVERABLE ☐ NO ☐ YES IF YES, TAC NUMBER ____________

REMARKS

NOTE: SAMPLES WILL BE DISCARDED AFTER ANALYSIS UNLESS REASONS ARE NOTED IN REMARKS ABOVE.

PAGE ____ OF ____

NRC FORM 303A
(4-2004)

U.S. NUCLEAR REGULATORY COMMISSION

SAMPLE RECORD – Continued

LABORATORY – ORISE

LABORATORY USE ONLY
CONTROL NUMBER

SAMPLE NUMBER	SAMPLE NAME AND DESCRIPTION	COLLECTION DATE/TIME	REMARKS, PRESERVATIVE ANALYSIS REQUESTED, ETC.

APPENDIX D

GZA GeoEnvironmental of New York

WELL ID: MW- -

Low-Flow Sampling Data Sheet

CLIENT: Entergy - IPEC

SITE: Buchanan, NY

SAMPLER: ______________________

WEATHER: ______________________

PROJECT NO: 41.0161619.00

DATE: ______________________

Pump Depth: ______________________ ft

WATER QUALITY:

Time	Depth to Water (ft)	pH (SU)	Specific Conductivity (S/cm)	Turbidity (NTU)	Dissolved Oxygen (g/l)	Temp (^{0}C)	ORP	Rate (gal/hr)	Notes

Equipment Used	Equipment Serial Number/ Identification Number

NOTES AND OBSERVATIONS:

All depth measurements are given from top of casing.

GZA GeoEnvironmental of New York
Waterloo Sampling
Data Sheet

WELL ID: MW- ___ - ___

CLIENT: Entergy - IPEC
SITE: Buchanan, NY
WEATHER: ____________

PROJECT NO: 41.0161619.00
DATE: ____________
SAMPLER(S): ____________

SAMPLING INTERVAL (depth in ft below top of casing)
________ to ________

SAMPLING PORT
____

TOTAL VOLUME PURGED:
________ gal

PURGE RATE: variable (gal / min)

GALLONS OF WATER PER WELL VOLUME:
Sampling Interval Length ________
x ____0.49 multiplier

WELL VOLUME: ________ gallons

PURGE METHOD: Double Valve Pump

WATER QUALITY:

Time	Purged Volume (gal)	pH (SU)	Specific Conductivity (S/cm)	Turbidity (NTU)	Dissolved Oxygen (g/l)	Temp (^{0}C)	ORP	Drive/Vent Cycle (seconds)	Drive Pressure (psi)

Equipment Used	Equipment Serial Number/ Identification Number

NOTES AND OBSERVATIONS:

GZA GeoEnvironmental of New York
Modified Traditional Purge
Sampling Data Sheet

WELL ID: MW- -

CLIENT: Entergy - IPEC
SITE: Buchanan, NY
WEATHER: ____________

PROJECT NO: 41.0161619.00
DATE: ____________
SAMPLER: ____________

WATER COLUMN HEIGHT (ft)

______ DTB - ______ DTW = ______ Well Column Height ft

Well Diameter: ______ inches

Diameter	Multipliers
1	0.041
2	0.163
4	0.653

GALLONS OF WATER PER WELL VOLUME:

Water Column Height ______ x ______ Multiplier = 0 Well Volume gallons

DESIGNED PURGE VOLUME: ______ x 1.5 = 0 Designed Purge Volume gallons

ACTUAL TOTAL VOLUME PURGED:

______ gal

PURGE METHOD: Waterra/ Footvalve

WATER QUALITY:

Time	Volume Purged (gal)	Depth to Water (ft)	pH (SU)	Specific Conductivity (S/cm)	Turbidity (NTU)	Dissolved Oxygen (g/l)	Temp (^{0}C)	ORP	Intake Depth (ft)	Notes

Equipment Used	Equipment Serial Number/ Identification Number

NOTES AND OBSERVATIONS:
All depth measurements are given from top of casing.

TRANSDUCER INSTALLATION LOG

GZA GEOENVIRONMENTAL OF NEW YORK 440 NINTH AVENUE, 18th FLOOR NEW YORK, NEW YORK 10001 SCIENTISTS AND ENGINEERS	Client Entergy Indian Point Energy Center	WELL ID SHEET 1 of 1 FILE NO. 41.0161619.00 PROJECT LOCATION Indian Point Energy Center

MANUFACTURER In-Situ
MAKE MiniTroll
PSI CAPACITY 30
SERIAL NUMBER

FINAL BORING DEPTH (FT)
GROUND ELEVATION (FT)
CASING ELEVATION (FT)
CASING DIAMETER (INCH)

DATUM NGVD 29
DATE

STATIC GROUNDWATER TABLE ELEVATION (FT)

GZA ENGINEER

ELEVATION OF MEASURING POINT - DEPTH TO WATER = REFERENCE ELEVATION (WATER TABLE ELEVATION)

DEPTH TO WATER + ACTUAL DEPTH = CABLE LENGTH (if transducer is functioning properly)

DEPTH TO BOTTOM: ______ FT
GROUND ELEVATION: ______ FT A.S.L.
CASING ELEVATION: ______ FT A.S.L.
CASING ABOVE (+) OR BELOW (-) GROUND: ______
DISTANCE FROM CASING TO GROUND (+ OR -): ______ FT
MEASURED CABLE LENGTH: ______ FT

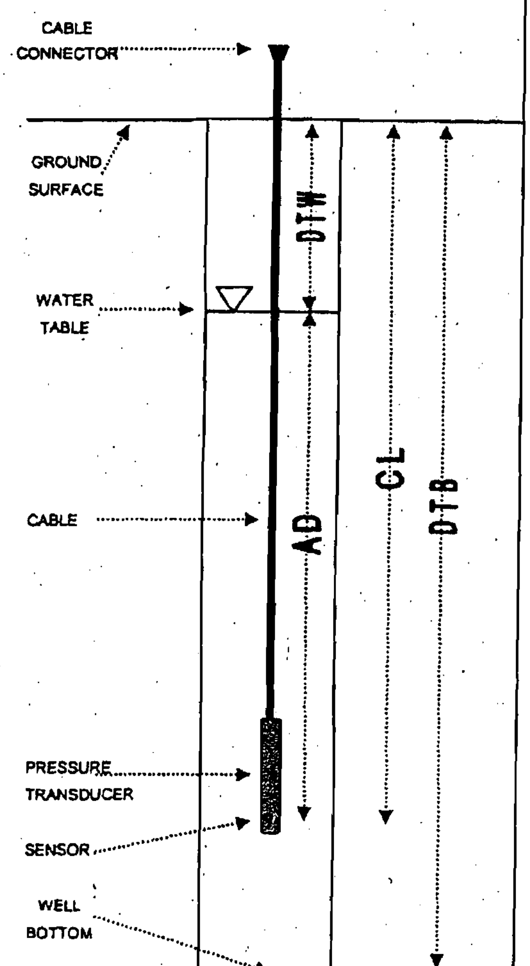
TIME OF MEASUREMENT: ______ HRS
MEASUREMENT TAKEN FROM: casing

DEPTH TO WATER: ______ FT
ACTUAL DEPTH: + ______ FT
THEORETICAL CABLE LENGTH: = ______ FT

HAVE CLOCKS BEEN SYNCHRONIZED? ☐ check
IS TRANSDUCER SET TO TAKE "SURFACE" READINGS? ☐ check

ELEVATION OF MEASURING POINT: ______ FT A.S.L.
DEPTH TO WATER: − ______ FT
REFERENCE ELEVATION: = ______ FT A.S.L.

TEST NAME: ______
LOGGING INTERVAL: ______ MIN
TEST START TIME: ______ HRS



LEGEND: DTW - DEPTH TO WATER
DTB - DEPTH TO BOTTOM OF WELL
AD - ACTUAL DEPTH OF TRANSDUCER UNDER WATER
CL - CABLE LENGTH FROM SENSOR TO GROUND SURFACE/ TOP OF CASING

NOTES:

GZA

WELL ID :

APPENDIX E

YSI **Environmental**

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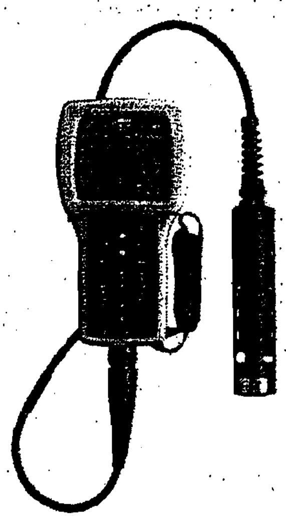

YSI 556 MPS
Multi Probe System

Operations Manual

Contents

6. Calibrate

All of the sensors, except temperature, require periodic calibration to assure high performance. You will find specific calibration procedures for all sensors that require calibration in the following sections. If a sensor listed is not installed in your probe module, skip that section and proceed to the next sensor until the calibration is complete.

⚠ **CAUTION:** Reagents that are used to calibrate and check this instrument may be hazardous to your health. Take a moment to review *Appendix D Health and Safety*. Some calibration standard solutions may require special handling.

6.1 Getting Ready to Calibrate

6.1.1 Containers Needed to Calibrate the Probe Module

The transport/calibration cup that comes with your probe module serves as a calibration chamber for all calibrations and minimizes the volume of calibration reagents required.

Instead of the transport/calibration cup, you may use laboratory glassware to perform calibrations. If you do not use the transport/calibration cup that is designed for the probe module, you are cautioned to do the following:

- ✓ Perform all calibrations with the Probe Sensor Guard installed. This protects the sensors from possible physical damage.
- ✓ Use a ring stand and clamp to secure the probe module body to prevent the module from falling over. Most laboratory glassware has convex bottoms.
- ✓ Ensure that all sensors are immersed in calibration solutions. Many of the calibrations factor in readings from other sensors (e.g., temperature sensor). The top vent hole of the conductivity sensor must also be immersed during some calibrations.

6.1.2 Calibration Tips

1. If you use the Transport/Calibration Cup for dissolved oxygen (DO) calibration, make certain to loosen the seal to allow pressure equilibration before calibration. The DO calibration is a water-saturated air calibration.

2. The key to successful calibration is to ensure that the sensors are completely submersed when calibration values are entered. Use recommended volumes when performing calibrations.

3. For maximum accuracy, use a small amount of previously used calibration solution to pre-rinse the probe module. You may wish to save old calibration standards for this purpose.

4. Fill a bucket with ambient temperature water to rinse the probe module between calibration solutions.

5. Have several clean, absorbent paper towels or cotton cloths available to dry the probe module between rinses and calibration solutions. Shake the excess rinse water off of the probe module, especially when the probe sensor guard is installed. Dry off the outside of the probe module and probe sensor guard. Making sure that the probe module is dry reduces carry-over contamination of calibrator solutions and increases the accuracy of the calibration.

6. If you are using laboratory glassware for calibration, you do not need to remove the probe sensor guard to rinse and dry the sensors between calibration solutions. The inaccuracy resulting from simply rinsing the sensor compartment and drying the outside of the guard is minimal.

7. If you are using laboratory glassware, remove the stainless steel weight from the bottom of the probe sensor guard by turning the weight counterclockwise. When the weight is removed, the calibration solutions have access to the sensors without displacing a lot of fluid. This also reduces the amount of liquid that is carried between calibrations.

8. Make certain that port plugs are installed in all ports where sensors are not installed. It is extremely important to keep these electrical connectors dry.

6.1.3 Recommended Volumes

Follow these instructions to use the transport/calibration cup for calibration procedures.

- ✓ Ensure that an o-ring is installed in the o-ring groove of the transport/calibration cup bottom cap, and that the bottom cap is securely tightened.

  NOTE: Do not over-tighten as this could cause damage to the threaded portions.
- ✓ Remove the probe sensor guard, if it is installed.
- ✓ Remove the o-ring, if installed, from the probe module and inspect the installed o-ring on the probe module for obvious defects and, if necessary, replace it with the extra o-ring supplied.
- ✓ Some calibrations can be accomplished with the probe module upright or upside down. A separate clamp and stand, such as a ring stand, is required to support the probe module in the inverted position.
- ✓ To calibrate, follow the procedures in the next section, Calibration Procedures. The approximate volumes of the reagents are specified below for both the upright and upside down orientations.
- ✓ When using the Transport/Calibration Cup for dissolved oxygen % saturation calibration, make certain that the vessel is vented to the atmosphere by loosening the bottom cap or cup assembly and that approximately 1/8" of water is present in the cup.

Sensor to Calibrate	Upright	Upside Down
Conductivity	55ml	55ml
pH/ORP	30ml	60ml

Table 6.1 Calibration Volumes

6.2 Calibration Procedures

6.2.1 Accessing the Calibrate Screen

1. Press the **On/off** key to display the run screen.
2. Press the **Escape** key to display the main menu screen.
3. Use the arrow keys to highlight the **Calibrate** selection.

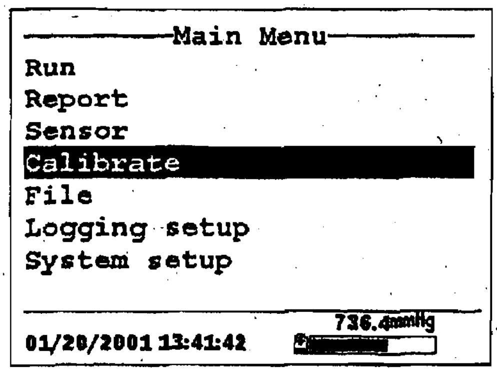

Figure 6.1 Main Menu

4. Press the **Enter** key. The Calibrate screen is displayed.

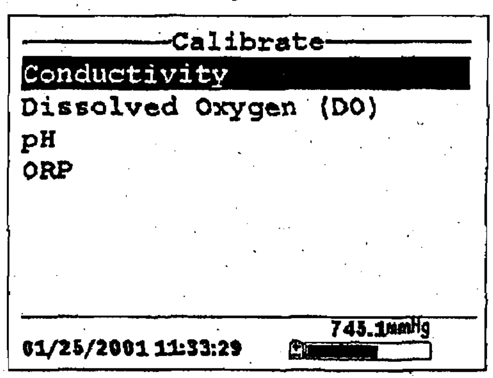

Figure 6.2 Calibrate Screen

6.2.2 Conductivity Calibration

This procedure calibrates specific conductance (recommended), conductivity and salinity. Calibrating any one option automatically calibrates the other two.

1. Go to the calibrate screen as described in Section 6.2.1 Accessing the Calibrate Screen.

2. Use the arrow keys to highlight the **Conductivity** selection. See Figure 6.2 Calibrate Screen.

3. Press **Enter.** The Conductivity Calibration Selection Screen is displayed.

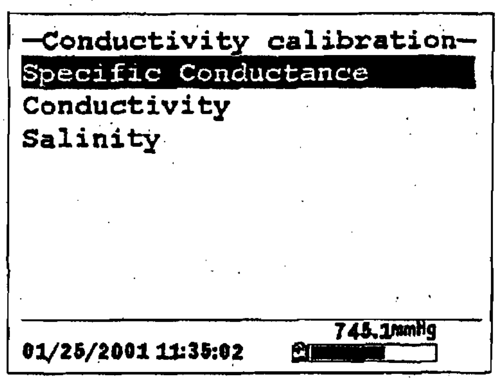

Figure 6.3 Conductivity Calibration Selection Screen

4. Use the arrow keys to highlight the Specific Conductance selection.

5. Press **Enter.** The Conductivity Calibration Entry Screen is displayed.

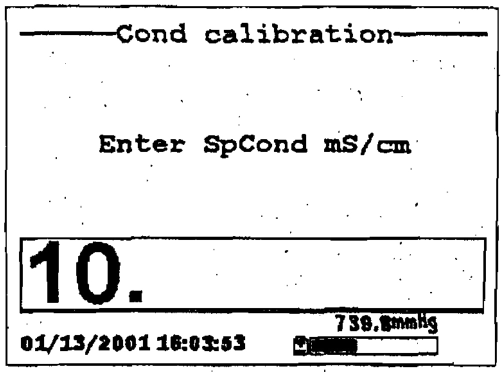

Figure 6.4 Conductivity Calibration Entry Screen

6. Place the correct amount of conductivity standard (see Table 6.1 Calibration Volumes) into a clean, dry or pre-rinsed transport/calibration cup.

⚠ **WARNING**: Calibration reagents may be hazardous to your health. See *Appendix D Health and Safety* for more information.

NOTE: For maximum accuracy, the conductivity standard you choose should be within the same conductivity range as the samples you are preparing to measure. However, we do not recommend using standards less than 1 mS/cm. For example:

✓ For fresh water use a 1 mS/cm conductivity standard.

✓ For brackish water use a 10 mS/cm conductivity standard.

✓ For seawater use a 50 mS/cm conductivity standard.

NOTE: Before proceeding, ensure that the sensor is as dry as possible. Ideally, rinse the conductivity sensor with a small amount of standard that can be discarded. Be certain that you avoid cross-contamination of solutions. Make certain that there are no salt deposits around the oxygen and pH/ORP sensors, particularly if you are employing standards of low conductivity.

7. Carefully immerse the sensor end of the probe module into the solution.

8. Gently rotate and/or move the probe module up and down to remove any bubbles from the conductivity cell.

   NOTE: The sensor must be completely immersed past its vent hole. Using the recommended volumes from Table 6.1 Calibration Volumes, should ensure that the vent hole is covered.

9. Screw the transport/calibration cup on the threaded end of the probe module and securely tighten.

   NOTE: Do not overtighten as this could cause damage to the threaded portions.

10. Use the keypad to enter the calibration value of the standard you are using.

    NOTE: Be sure to enter the value in **mS/cm at 25°C.**

11. Press **Enter**. The Conductivity Calibration Screen is displayed.

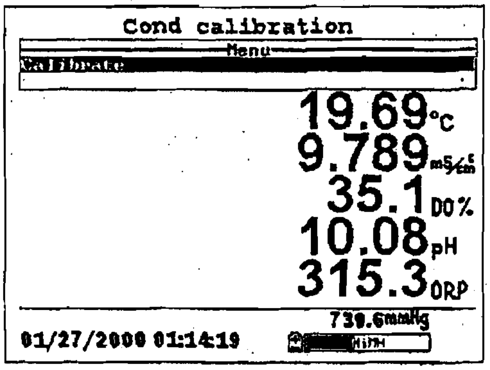

Figure 6.5 Conductivity Calibration Screen

12. Allow at least one minute for temperature equilibration before proceeding. The current values of all enabled sensors

will appear on the screen and will change with time as they stabilize.

13. Observe the reading under Specific Conductance. When the reading shows no significant change for approximately 30 seconds, press **Enter**. The screen will indicate that the calibration has been accepted and prompt you to press **Enter** again to Continue.

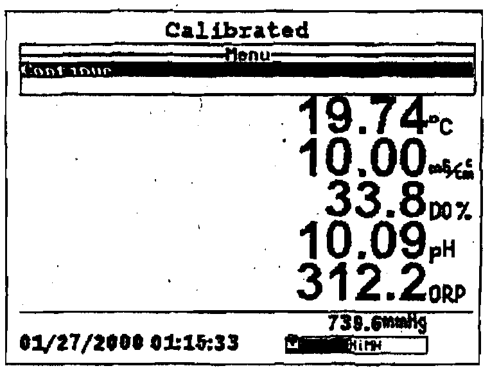

Figure 6.6 Calibrated

14. Press **Enter**. This returns you to the Conductivity Calibrate Selection Screen, See Figure 6.3 Conductivity Calibration Selection Screen.

15. Press **Escape** to return to the calibrate menu. See Figure 6.2 Calibrate Screen.

16. Rinse the probe module and sensors in tap or purified water and dry.

6.2.3 Dissolved Oxygen Calibration

This procedure calibrates dissolved oxygen. Calibrating any one option (% or mg/L) automatically calibrates the other.

1. Go to the calibrate screen as described in Section *6.2.1 Accessing the Calibrate Screen.*

NOTE: The instrument must be on for at least 20 minutes to polarize the DO sensor before calibrating.

2. Use the arrow keys to highlight the **Dissolved Oxygen** selection. See Figure 6.2 Calibrate Screen.

3. Press **Enter**. The dissolved oxygen calibration screen is displayed.

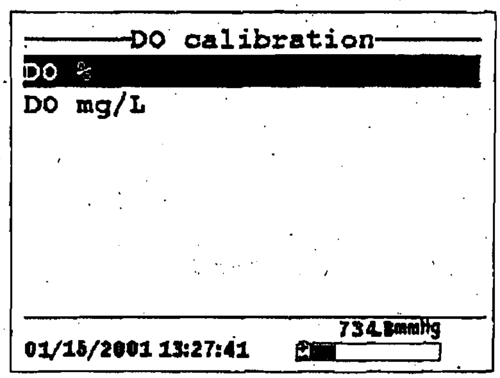

Figure 6.7 DO Calibration Screen

DO Calibration in % Saturation

1. Use the arrow keys to highlight the DO% selection.

2. Press **Enter**. The DO Barometric Pressure Entry Screen is displayed.

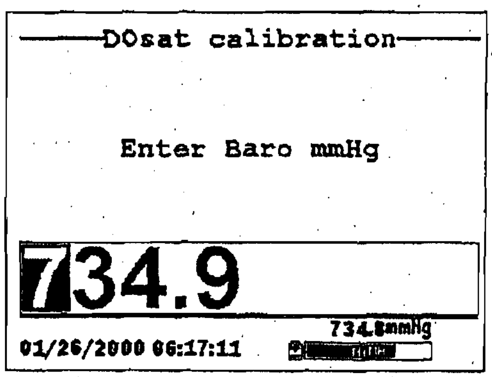

Figure 6.8 DO Barometric Pressure Entry Screen

3. Place approximately 3 mm (1/8 inch) of water in the bottom of the transport/calibration cup.

4. Place the probe module into the transport/calibration cup.

   NOTE: Make sure that the DO and temperature sensors are **not** immersed in the water.

5. Engage only 1 or 2 threads of the transport/calibration cup to ensure the DO sensor is vented to the atmosphere.

6. Use the keypad to enter the current local barometric pressure.

   NOTE: If the unit has the optional barometer, no entry is required.

   NOTE: Barometer readings that appear in meteorological reports are generally corrected to sea level and must be uncorrected before use (refer to Section *10.10 Calibrate Barometer, Step 2*).

7. Press **Enter**. The DO% saturation calibration screen is displayed.

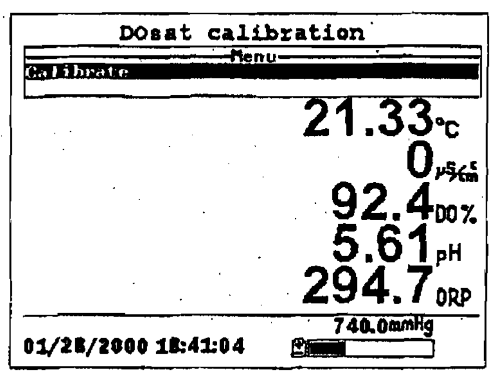

Figure 6.9 DO Sat Calibration Screen

8. Allow approximately ten minutes for the air in the transport/calibration cup to become water saturated and for

the temperature to equilibrate before proceeding. The current values of all enabled sensors will appear on the screen and will change with time as they stabilize.

9. Observe the reading under DO %. When the reading shows no significant change for approximately 30 seconds, press **Enter**. The screen will indicate that the calibration has been accepted and prompt you to press **Enter** again to Continue. See Figure 6.6 Calibrated.

10. Press **Enter**. This returns you to the DO calibration screen, See Figure 6.7 DO Calibration Screen.

11. Press **Escape** to return to the calibrate menu. See Figure 6.2 Calibrate Screen.

12. Rinse the probe module and sensors in tap or purified water and dry.

DO Calibration in mg/L

DO calibration in mg/L is carried out in a water sample which has a known concentration of dissolved oxygen (usually determined by a Winkler titration).

1. Go to the DO calibrate screen as described in Section *6.2.3 Dissolved Oxygen Calibration*, steps 1 through 3.

2. Use the arrow keys to highlight the **DO mg/L** selection.

3. Press **Enter**. The DO mg/L Entry Screen is displayed.

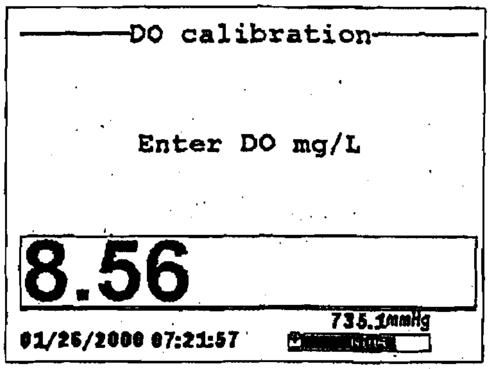

Figure 6.10 DO mg/L Entry Screen

4. Place the probe module in water with a known DO concentration.

   NOTE: Be sure to completely immerse all the sensors.

5. Use the keypad to enter the known DO concentration of the water.

6. Press **Enter**. The Dissolved Oxygen mg/L Calibration Screen is displayed.

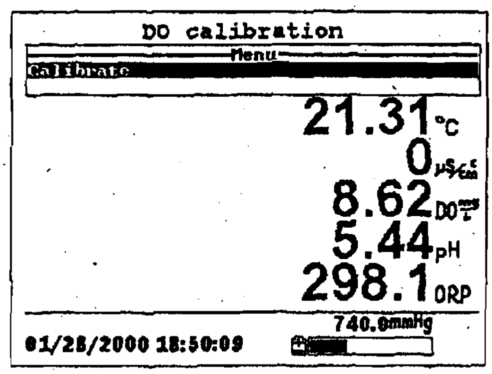

Figure 6.11 DO mg/L Calibration Screen

7. Stir the water with a stir bar, or by rapidly moving the probe module, to provide fresh sample to the DO sensor.

8. Allow at least one minute for temperature equilibration before proceeding. The current values of all enabled sensors will appear on the screen and will change with time as they stabilize.

9. Observe the DO mg/L reading, when the reading is stable (shows no significant change for approximately 30 seconds), press **Enter**. The screen will indicate that the calibration has been accepted and prompt you to press **Enter** again to Continue.

10. Press **Enter**. This returns you to the DO calibration screen. See Figure 6.7 DO Calibration Screen.

11. Press **Escape** to return to the calibrate menu. See Figure 6.2 Calibrate Screen.

12. Rinse the probe module and sensors in tap or purified water and dry.

6.2.4 pH Calibration

1. Go to the calibrate screen as described in *Section 6.2.1 Accessing the Calibrate Screen.*

2. Use the arrow keys to highlight the **pH** selection. See Figure 6.2 Calibrate Screen.

3. Press **Enter**. The pH calibration screen is displayed.

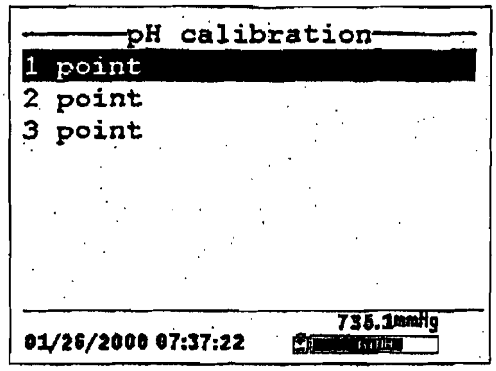

Figure 6.12 pH Calibration Screen

- Select the **1-point** option only if you are adjusting a previous calibration. If a 2-point or 3-point calibration has been performed previously, you can adjust the calibration by carrying out a one point calibration. The procedure for this calibration is the same as for a 2-point calibration, but the software will prompt you to select only one pH buffer.
- Select the **2-point** option to calibrate the pH sensor using only two calibration standards. Use this option if the media being monitored is known to be either basic or acidic. For example, if the pH of a pond is known to vary between 5.5 and 7, a two-point calibration with pH 7 and pH 4 buffers is sufficient. A three point calibration with an additional pH 10 buffer will not increase the accuracy of this measurement since the pH is not within this higher range.
- Select the **3-point** option to calibrate the pH sensor using three calibration solutions. In this procedure, the pH sensor is calibrated with a pH 7 buffer and two additional buffers. The 3-point calibration method assures maximum accuracy when the pH of the media to be monitored cannot be anticipated. The procedure for this calibration is the same as for a 2-point calibration, but the software will prompt you to select a third pH buffer.

4. Use the arrow keys to highlight the **2-point** selection.

5. Press **Enter**. The pH Entry Screen is displayed.

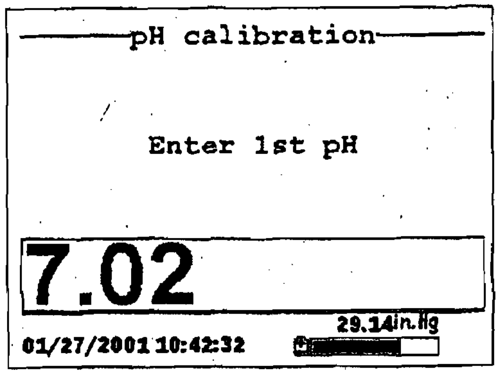

Figure 6.13 pH Entry Screen

6. Place the correct amount (see Table 6.1 Calibration Volumes) of pH buffer into a clean, dry or pre-rinsed transport/calibration cup.

⚠ **WARNING**: Calibration reagents may be hazardous to your health. See *Appendix D Health and Safety* for more information.

NOTE: For maximum accuracy, the pH buffers you choose should be within the same pH range as the water you are preparing to sample.

NOTE: Before proceeding, ensure that the sensor is as dry as possible. Ideally, rinse the pH sensor with a small amount of buffer that can be discarded. Be certain that you avoid cross-contamination of buffers with other solutions.

7. Carefully immerse the sensor end of the probe module into the solution.

8. Gently rotate and/or move the probe module up and down to remove any bubbles from the pH sensor.

NOTE: The sensor must be completely immersed. Using the recommended volumes from Table 6.1 Calibration Volumes, should ensure that the sensor is covered.

9. Screw the transport/calibration cup on the threaded end of the probe module and securely tighten.

   NOTE: Do not overtighten as this could cause damage to the threaded portions.

10. Use the keypad to enter the calibration value of the buffer you are using **at the current temperature**.

    NOTE: pH vs. temperature values are printed on the labels of all YSI pH buffers.

11. Press **Enter**. The pH calibration screen is displayed.

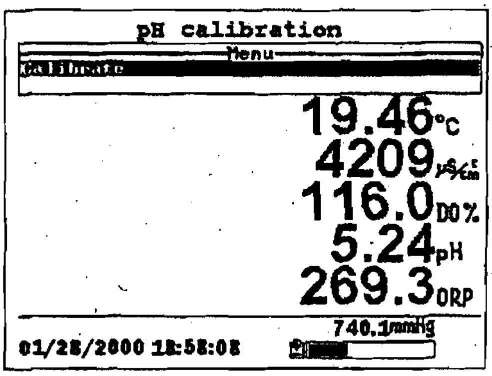

Figure 6.14 pH Calibration Screen

12. Allow at least one minute for temperature equilibration before proceeding. The current values of all enabled sensors will appear on the screen and will change with time as they stabilize.

13. Observe the reading under pH, when the reading shows no significant change for approximately 30 seconds, press **Enter**. The screen will indicate that the calibration has been accepted and prompt you to press **Enter** again to Continue.

14. Press **Enter**. This returns you to the Specified pH Calibration Screen, See Figure 6.13 pH Entry Screen.

15. Rinse the probe module, transport/calibration cup and sensors in tap or purified water and dry.

16. Repeat steps 6 through 13 above using a second pH buffer.

17. Press **Enter**. This returns you to the pH Calibration Screen, See Figure 6.12 pH Calibration Screen.

18. Press **Escape** to return to the calibrate menu. See Figure 6.2 Calibrate Screen.

19. Rinse the probe module and sensors in tap or purified water and dry.

6.2.5 ORP Calibration

1. Go to the calibrate screen as described in Section *6.2.1 Accessing the Calibrate Screen.*

2. Use the arrow keys to highlight the **ORP** selection. See Figure 6.2 Calibrate Screen.

3. Press **Enter**. The ORP calibration screen is displayed.

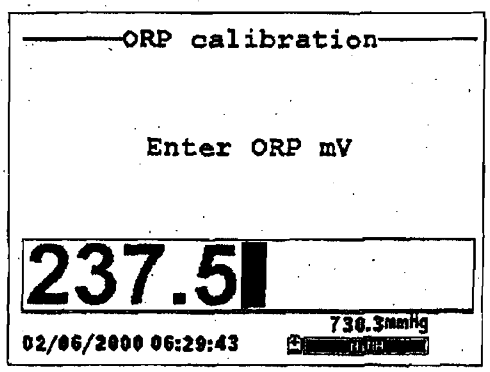

Figure 6.15 Specified ORP Calibration Screen

4. Place the correct amount (see Table 6.1 Calibration Volumes) of a known ORP solution (we recommend Zobell solution) into a clean, dry or pre-rinsed transport/calibration cup.

⚠ **WARNING:** Calibration reagents may be hazardous to your health. See *Appendix D Health and Safety* for more information.

NOTE: Before proceeding, ensure that the sensor is as dry as possible. Ideally, rinse the ORP sensor with a small amount of solution that can be discarded. Be certain that you avoid cross-contamination with other solutions.

5. Carefully immerse the sensor end of the probe module into the solution.

6. Gently rotate and/or move the probe module up and down to remove any bubbles from the ORP sensor.

NOTE: The sensor must be completely immersed. Using the recommended volumes from Table 6.1 Calibration Volumes should ensure that the sensor is covered.

7. Screw the transport/calibration cup on the threaded end of the probe module and securely tighten.

NOTE: Do not overtighten as this could cause damage to the threaded portions.

8. Use the keypad to enter the correct value of the calibration solution you are using at the current temperature. Refer to Table 6.2 Zobel Solution Values.

Temperature °C	Zobell Solution Value, mV
-5	270.0
0	263.5
5	257.0
10	250.5
15	244.0
20	237.5
25	231.0
30	224.5
35	218.0
40	211.5
45	205.0
50	198.5

Table 6.2 Zobel Solution Values

9. Press **Enter**. The ORP calibration screen is displayed.

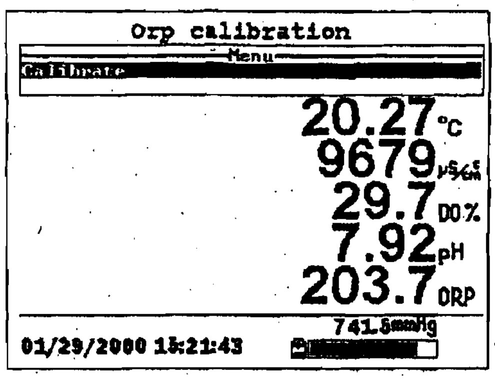

Figure 6.16 ORP Calibration Screen

10. Allow at least one minute for temperature equilibration before proceeding. The current values of all enabled sensors will appear on the screen and will change with time as they stabilize.

    NOTE: Verify that the temperature reading matches the value you used in Table 6.2 Zobel Solution Values.

11. Observe the reading under ORP, when the reading shows no significant change for approximately 30 seconds, press **Enter**. The screen will indicate that the calibration has been accepted and prompt you to press **Enter** again to Continue.

12. Press **Enter**. This returns you to the Calibrate Screen. See Figure 6.2 Calibrate Screen.

13. Rinse the probe module and sensors in tap or purified water and dry.

6.3 Return to Factory Settings

1. Go to the calibrate screen as described in Section *6.2.1 Accessing the Calibrate Screen*.

2. Use the arrow keys to highlight the **Conductivity** selection. See Figure 6.2 Calibrate Screen.

   NOTE: We will use the Conductivity sensor as an example; however, this process will work for any sensor.

3. Press **Enter.** The Conductivity Calibration Selection Screen is displayed. See Figure 6.3 Conductivity Calibration Selection Screen.

4. Use the arrow keys to highlight the **Specific Conductance** selection.

5. Press **Enter.** The Conductivity Calibration Entry Screen is displayed. See Figure 6.4 Conductivity Calibration Entry Screen.

6. Press and hold the **Enter** key down and press the **Escape** key.

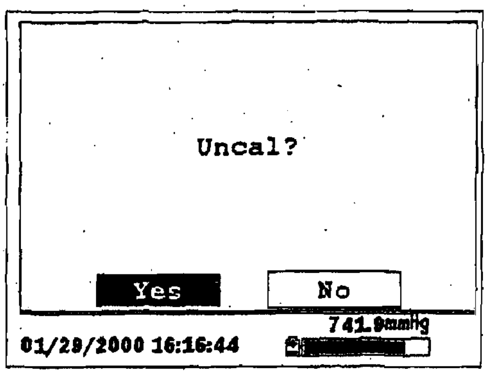

Figure 6.17 ORP Calibration Screen

7. Use the arrow keys to highlight the **YES** selection.

CAUTION: This returns a sensor to the factory settings. For example, in selecting to return specific conductance to the factory setting, salinity and conductivity will automatically return to their factory settings.

8. Press **Enter**. This returns you to the Conductivity Calibrate Selection Screen, See Figure 6.3 Conductivity Calibration Selection Screen.

9. Press **Escape** to return to the calibrate menu. See Figure 6.2 Calibrate Screen.