Zavoral Mining and Reclamation Project
Groundwater Quality Protection Plan

TILLER
CORPORATION®

7200 Hemlock Lane North Maple Grove, MN 55311
Phone: (763) 425-4191 Fax: (763) 425-7153

TILLER CORPORATION (Tiller)
ZAVORAL MINING AND RECLAMATION PROJECT
GROUNDWATER QUALITY PROTECTION PLAN

1. INTRODUCTION AND PURPOSE

Protection of the quantity and quality of groundwater resources is vital. Groundwater interacts with, and plays an important role in sustaining, several high value surface water resources within the region and within the immediate vicinity of the Zavoral Mining and Reclamation Project. This plan has been prepared to identify specific measures to be adopted to minimize or eliminate the potential for any impacts to the groundwater and to provide for monitoring of the groundwater throughout the duration of mining and reclamation activity.

2. GEOLOGIC AND HYDROLOGIC SETTING:

The geologic setting of the site is an upper stream terrace of the St. Croix River. The stream terrace consists of 10-100 feet of sand, gravelly sand and gravel. The Cambrian Jordan Sandstone forms the first bedrock contact beneath the unconsolidated material throughout most of the mining area. The Ordovician Prairie du Chien Group forms the bedrock subcrop beneath the very northern portion of the mining area. The top of the bedrock surface varies from approximately 770-850 feet above mean sea level (msl). East of the mining area towards the St. Croix River, the entire section of the Jordan Sandstone has been eroded away and the St. Lawrence Formation, the Tunnel City Group (formerly named the Franconia Formation) and Wonewoc Sandstone (formerly named the Ironton & Galesville Sandstones) form the bedrock subcrop within the St. Croix River Valley.

Based on information collected during the environmental review process, the elevation of the groundwater table beneath the site varies from approximately 840 feet above msl in the western portion of the site to a level of just below 700 feet above msl at the river. Seeps and springs located along the bluffs of the river are a reflection of the groundwater table intersecting the ground surface. The substantial change in the elevation of the water table over the Site is a reflection of the strong easterly gradient towards the discharge area of the St. Croix River Valley.

3. IMPLEMENTATION OF BEST MANAGMENT PRACTICES:

There are a number of site Best Management Practices (BMPs) and technologies available that are discussed below which eliminate or minimize the potential for introduction of contaminant sources into the underlying soil and groundwater system. The following measures will be taken to protect groundwater quality:

3.1 Limited equipment maintenance will be performed on-site and Tiller's spill prevention policies will be followed.

3.2 A service truck will come to the site to perform routine maintenance. All used lubricating oil will be collected by facility personnel and hauled off-site to a central collection point (waste oil is not classified as hazardous waste). The service truck carries a spill containment kit.

3.3 Any fuel stored on site will be stored in above ground tanks with secondary containment in accordance with MPCA and local rules. Secondary containment will consist of an impermeable enclosure with an impermeable base or approved double walled tanks. In the event of a tank failure, the secondary containment will prevent the release of petroleum products to the environment. Alternatively, a service truck may be used to fuel equipment as needed.

3.4 Equipment fueling will be conducted in a designated area over a hard surfaced fueling pad. This will allow uniform control over refueling operations. The pad will allow easy visual detection and facilitate clean-up of any spills or drips which may occur.

3.5 A Spill Prevention Control and Counter Measures Plan (SPCC Plan) will be prepared for the site. This plan will document procedures to be followed in the event of a spill or release at the site. Tiller's policy regarding spills is that any spill of oil, gasoline, diesel fuel, or lubricant is to be reported to Paul Schultz P.G., Tiller's Land Use Coordinator, and cleaned up promptly. Any spills of 5 gallons or more of petroleum products or any volume of hazardous materials are reported to the state duty officer as required by applicable state statutes and regulations (Minn. Stat. 299K)

3.6 Topping off tanks of any kind is not allowed under company procedures.

3.7 Spill cleanup equipment will be available on-site including equipment to excavate and remove impacted soils in an expedited fashion, fire extinguishers, absorbent pads, spill blocker dikes, empty barrels, rags and shovels.

4. GROUNDWATER MONITORING PLAN

4.1 Monitoring Well Installation

One groundwater monitoring well will be installed on the eastern portion of the proposed mining limits downgradient of the fueling area. The well will be completed and screened within the upper portion of the groundwater table. Figure 1 illustrates the location of the well, the refueling area, the elevation of the water table and the direction of groundwater flow.

4.2 Monitoring Well Sampling

Groundwater samples will be collected and analyzed on an annual basis for Diesel Range Organics (DRO). At the time of the sampling event a water level reading will also be recorded. Sampling results will be submitted to the City on an annual basis in conjunction with the annual report. The report will include all previous years' data and will be in a spreadsheet or graph form to facilitate identifying trends in water quality.

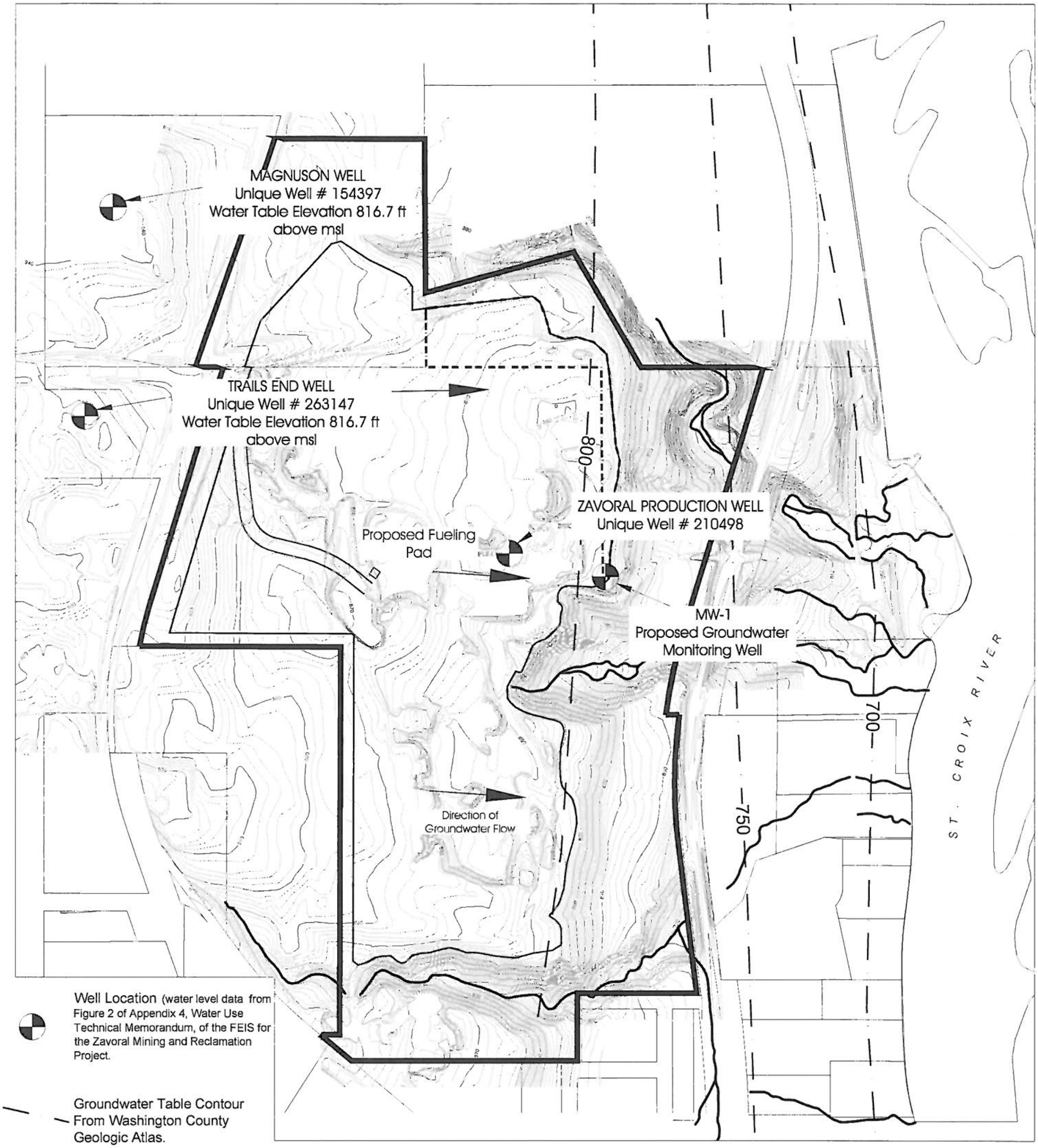
In the event a sample result is greater than or equal to 1 mg/L DRO then an analysis for polycyclic aromatic hydrocarbons (PAH) will be conducted. In the event a sample result is over 0.1 mg/L DRO but less than 1 mg/L DRO a resampling and analysis will take place. If the second sample result is over 0.1mg/L DRO then an analysis for PAH willl be conducted.

A baseline monitoring event will be conducted prior to the commencement of mining activities.

If operating conditions change to include the storage of gasoline on the site, GRO and benzene will be added to the sampling parameter list for monitoring well (Well ID#).

5.0 Sampling Protocol

PACE laboratories will be subcontracted to collect and analyze the samples. Pace is an independent laboratory certified by the Minnesota Department of Health. Sampling protocol is included as Attachment 1. Tiller will notify the City if the sampling protocol is modified.



Well Location (water level data from Figure 2 of Appendix 4, Water Use Technical Memorandum, of the FEIS for the Zavoral Mining and Reclamation Project.

Groundwater Table Contour From Washington County Geologic Atlas.

Groundwater Flow Direction

Groundwater Monitoring Plan
Figure 1

Attachment 1

Sampling Protocol

Sampling Protocol

1.0 DECONTAMINATION

Equipment used to collect samples must be decontaminated before use. These procedures are applicable to most sampling equipment components; refer to manufacturer specifications for compatibility concerns.

Pace FSD uses certified clean sample containers. Cleaning of sample containers is not necessary if sample is collected directly into new, certified sample container for desired analyte.

1.1 Drinking Water Decontamination

1.1.1 Sampling for Inorganic Analytes

Note: the following procedure may be preceded by a vigorous flushing of hot tap water to remove gross amounts of contamination as necessary.

1. Soak and scrub components in hot tap water containing laboratory grade soap.
2. Triple rinse with hot tap water.
3. Final rinse with deionized (DI) water
4. Drain or allow components to air dry when possible.

1.1.2 Sampling for Semi-Volatile Organic Analytes

1. Remove any gross visible contamination by scrubbing and flushing with hot tap water.
2. Soak and scrub components in hot tap water containing laboratory grade soap.
3. Triple rinse with hot tap water.
4. Triple rinse with DI water.
5. Rinse with acetone or methanol.
6. Optional final rinse with methylene chloride.
7. Wrap cleaned equipment in aluminum foil shiny side out.

1.1.3 Sampling for Volatile Organic Analytes

1. Remove any gross visible contamination by scrubbing and flushing with hot tap water.

2. Soak and scrub components in hot tap water containing laboratory grade soap.

3. Triple rinse with hot tap water.

4. Triple rinse with DI water.

5. Place components in oven for a minimum of 1 hour at 105ºC or greater.

6. Wrap component in aluminum foil shiny side out.

1.2 Groundwater Decontamination

All pumps used to obtain groundwater samples will be decontaminated before use in the field. New or dedicated pump tubing will be used for each sampling location. Dedicated tubing will be stored between sampling events in a sealed, chemically inert plastic bag labeled with the site location. Pump bladders may be dedicated in this same manner.

Take appropriate measures to minimize potential contamination during transport and handling of sampling equipment. Avoid introducing surface or ambient air contamination into monitoring well. Permanently installed sampling equipment is exempt from decontamination procedures. Field cleaning procedures will be performed on equipment used at multiple sampling locations to minimize cross-contamination.

1.2.1 Pump Decontamination Before Field Use

1. Scrub and flush pump exterior with laboratory grade soap and hot tap water.

2. Fill tank with hot tap water containing laboratory grade soap.

3. Place pump in tank and pump approximately 10 gallons through pump.

4. Fill tank with DI water.

5. Place pump in tank and pump approximately 10 gallons through pump.

1.2.2 Pump Cleaning Onsite

1. Scrub and flush pump exterior with laboratory grade soap and water.

2. Rinse pump exterior with DI water.

3. Place pump in DI tank and pump approximately 1 gallon of DI water through pump.

1.2.3 Bailer

A bailer may be used to obtain water samples from difficult to access sample points. Bailers consist of a tube with a one-way check valve at the bottom. Bailers are made in various styles, materials, lengths and widths. Water fills the bailer as it is lowered into the source. The check value closes to contain the sample as it is retrieved. Minimize disturbance of water by gently lowering the bailer into the sample point.

Allow the bailer to fill under its own weight. Keep bailer away from sides and bottom of sample point. Contact with surfaces may disturb particulate matter biasing the water sample. After it fills, use a smooth motion to slowly retrieve the bailer.

Stainless Steel Bailer Decontamination

1. Remove any gross visible contamination by scrubbing and flushing with hot tap water.

2. Soak and scrub components in hot tap water containing laboratory grade soap.

3. Triple rinse with hot tap water.

4. Triple rinse with DI water.

5. Place components in oven for a minimum of 1 hour at 105ºC or greater.

6. Wrap component in aluminum foil shiny side out.

2.0 Stabilization

A representative sample of groundwater formation is collected by purging stagnant water from the well prior to sample collection. The purging process includes determining the volume of water in the well casing, purging stagnant water from the well, and monitoring this purged water for water quality indicator parameters.

Static water level, the level of water in an undisturbed well, and total well depth are measured and recorded for all wells. The static water level is measured and recorded before purging and after sampling at each well. Total well depth may already be established and provided on the client data sheet, client sampling plan, or Pace proposal. If total well depth is not predetermined, use a water level indicator to obtain measurements.

Static water level and total well depth determine the well purging volume and identify the proper intake depth during purging and sampling procedures. They may also be used to identify the direction of groundwater flow. To establish a measurement for water levels, a minimum of two water level measurements are taken with values agreeing within 0.01 foot.

2.1 Water Level Determination

Procedure

1. Hold the water level meter vertically above the well case opening and take all measurements from the point marked at the top of the well casing. The tape should not rub against the top of the casing as it is lowered and raised; cover any sharp edges to protect tape if necessary.

2. Thoroughly rinse probe with DI water and perform sensitivity calibration. Setting the meter's sensitivity will avoid false triggering.
   a. Turn instrument on using the ON/SENSITIVITY switch.
   b. Lower probe into well. The light and buzzer will activate when the probe contacts the water surface.
   c. With the probe still in contact with the water, turn the ON/SENSITIVITY dial counter-clockwise until the light/buzzer turns off. Then turn the dial clockwise until the light/buzzer barely activates.

3. Determine the static water level.
   a. Slowly lower the water level indicator probe down into the well until the indicator light comes on and/or the buzzer sounds. Dip the probe in and out of the water several times to confirm the exact point at which the probe is hitting the water.
   b. Take reading from the tape at the appropriate reference point. Measure a second time to confirm initial measurement. Measurements should agree within 0.01 foot. Take additional readings if necessary.
   c. Record static water level to the nearest 0.01 foot (meters x 3.281 = feet) on the Field Data Log Sheet.

4. Determine the total well depth, if necessary.
   a. Lower probe into the well until it hits the bottom and take reading from the appropriate reference point. Measure a second time to confirm initial measurement. Measurements should agree within 0.01 foot. Take additional readings if necessary.
   b. Record total well depth to the nearest 0.01 foot (meters x 3.281 = feet) on the Field Data Log Sheet.
   c. After completing required measurements, rewind the tape being careful not to rub it against the casing.

5. Clean meter after use at each well.
   a. For static water level and total well depth measurements, wash probe with soapy water and thoroughly rinse with DI water.
   b. Additionally, after total well depth measurement, wipe any tape having contacted well water with a DI soaked tissue, or equivalent, while reeling in tape.

2.2 Well Volume Determination

Determine the well volume for the purging process using static water level, total well depth, and well diameter measurements. Water column length is found by subtracting the static water level from the total well depth.

Water Column length (ft) = Well Depth (ft) (-) Static Water Level (ft)

Water column length is then multiplied by the well diameter multiplication factor to obtain the well water volume. Refer to the Bore Volume Chart (Figure IV) to determine the water volume within circular well casings.

Well Volume (gal) = Water Column length (ft) (x) Well Diameter Multiplication Factor

2.3 Water Quality Indicator Parameters (WQIP)

Water quality indicator parameters (WQIP) are monitored to determine when formation water has been reached during the purging process. WQIP are measured after each water column volume or partial volume, depending on project specifications, is purged. Purged water is directed through a flow cell to minimize changes in temperature, pressure, and influences of outside elements while WQIP are measured.

The client data sheet, client sampling plan, or Pace proposal will specify the parameters and frequency of measurement in determining well stabilization for a given sampling location. Turbidity and ORP measurements are generally not WQIP, although these parameters may be measured in the field per client request or project objectives. Monitor WQIP carefully to keep purging to a minimum. Excessive purging may damage the monitored zone. A well is presumed to be ready for sample collection when at least three successive readings for each WQIP are observed to vary less than the following criteria, unless otherwise specified by project objectives:

- pH: +/- 0.1 units
- Temp: +/- 0.5°C
- Specific Conductance: +/- 5%
- Dissolved Oxygen: +/- 0.5mg/L

2.4 Well Purging

Purging is the process of removing stagnant water from a well before sampling, which then allows a representative groundwater sample to be collected from the adjacent formation water flowing into the well. Typically, purging is completed immediately before sample collection, although samples are acceptable if collected within 24 hours of purging. Project specifications may require sampling to occur within a set time after the purging process.

All attempts will be made to avoid purging wells to dryness. Excessive purging can increase or decrease the contaminant concentrations that would otherwise be found in a representative sample from a well. Monitor the static water level throughout the purging process to track drawdown and assist in flow rate adjustments. Reduce pump rate to avoid pumping the well dry and to ensure stabilization criteria are achieved when possible.

For a well that has been purged dry, it is assumed recharge water is fresh from the groundwater formation. Under ideal conditions, a well that has been purged to dryness is permitted to recover 100% before sample collection. At a minimum, let a well recharge for a period of time sufficient to allow an adequate water volume to return for the desired sampling parameters. Check the recharge of the well using a water level meter until a sufficient depth is measured to ensure a sufficient amount of water is in the well before sampling. If the recharge time is relatively long (> 1 hour), it is up to the discretion of the technician and client as to whether sampling proceeds.

2.4.1 Pump Procedure

1. Start purging well by withdrawing water from desired depth using appropriate purging procedure for project objectives and well conditions. Use a purge rate dictated by project's sampling plan; if a rate is not indicated, use a purge rate that will minimize drawdown while allowing a reasonable purge time. Check the water level during purging to track drawdown; adjust the pump depth as necessary if the water level drops.

2. Measure and record the purge rate using a bucket and stopwatch.
   a. Collect the purging discharge into a bucket with volumetric markings for a timed interval (15 seconds, 30 seconds, 1 minute).
   b. Determine the purge rate in gallons per minute, or equivalent units, by multiplying the set length of time and the volume collected in the bucket.

3. Inspect flow cell to ensure proper sealing. Connect discharge line to the intake point of the flow cell. Maintain discharge through flow cell(s) at a continuous and steady rate.

4. Immerse applicable field analytical probes into flow cell(s) to measure stabilization criteria. Allow probes to equilibrate for approximately 5 minutes before taking readings.

5. Remove one well volume or partial well volume.

6. Record WQIP readings on appropriate data sheet.

7. Continue purging until another well volume or partial well volume has been removed.

8. Record WQIP on appropriate data sheet.

9. Continue process until 3 or more consecutive measurements within the specified target stabilization criteria are obtained. If stabilization criteria has not been met after the removal of 5 water column volumes, contact project administrator or client for approval to collect sample. Clearly document that stabilization was not achieved if sampling is to proceed.

10. Collect required samples.

2.4.2 Bailer Procedure

1. Anchor desired line or set-up surveyor's tripod and down rigger reel above the center of the well casing.

2. Connect bailer to line or down rigger cable.

3. Keep bailer and line away from sides and bottom of well. Contact with these surfaces may disturb particulate matter biasing the sample. Minimize disturbance and aeration of water by gently lowering the bailer into the sampling point; avoid splashing bailer into water.

4. Allow bailer to fill under its own weight.

5. Slowly withdraw bailer from the well using a smooth, steady motion.

6. Measure and record each volume removed by pouring sample into clean, unpreserved container. Perform stabilization readings as specified by project objectives.

7. Once stabilization criteria have been met, collect required samples.

3.0 Sample Collection

Analytical parameters required for sampling are based on regulatory requirements and site history. These analytical parameters are specified on a project's client data sheet, client sampling plan, or Pace proposal. Samples will be collected in a manner that minimizes potential contamination. A new pair of gloves will be worn at each sampling location and changed after contact with possible contaminants. If vehicles or generators are running during sample collection, containers will be filled upwind from exhaust sources.

3.1 Groundwater Procedure

1. After well stabilization is achieved and documented, complete necessary information on sample labels and adhere to appropriate sample containers.

2. If provided, use the sample rate specified by project's sampling plan. If not provided, the sample rate will be the same as the rate used during the final stage of purging. Sample rate is lowered significantly when sampling for VOCs to approximately 100 mL per minute.

3. Remove discharge line from flow cell maintaining a continuous discharge and collect required QA/QC samples.

4. Collect field samples in the following order if applicable, unless otherwise specified. Do not overfill preserved sample bottles.

    i. VOCs
    ii. Metals
    iii. SVOCs
    iv. TOC
    v. TOX
    vi. Phenols
    vii. Nitrogen series
    viii. Cyanide
    ix. General Parameters

5. Log all samples on chain of custody.

6. Samples requiring thermal preservation are to be placed in cooler with ice to obtain appropriate cooling temperature specified by parameter preservation requirements.

7. After all samples have been collected, measure and record the static water level to the nearest 0.01 foot.

8. Complete relevant paperwork for sampled well.

9. Thoroughly clean all equipment to be used on additional wells before moving to next location.

10. Review project scope to confirm all requirements have been fulfilled before leaving the site.