



MEMORANDUM

TO: Don Stilz (IDEM)

REF. NO.: 17324

FROM: Shannon Richardson/sr/8

DATE: October 22, 2010

C.C.: Dave Favero (MLC)

RE: **Off-Site Groundwater Investigation
Motors Liquidation Company**

1.0 INTRODUCTION

Conestoga-Rovers & Associates (CRA) has prepared this memorandum, on behalf of Motors Liquidation Company (MLC), to provide the Indiana Department of Environmental Management (IDEM) with a scope of work (SOW) for a proposed off-Site groundwater investigation downgradient of the former Manual Transmissions of Muncie facility in Muncie, Indiana (Site). A Site location map is provided on Figure 1.

The last Site-wide groundwater monitoring event showed groundwater impacts above IDEM's Risk Integrated System of Closure (RISC) Residential and Industrial Default Closure Criteria at the north property boundary (Figure 2). As such, MLC proposes to conduct an off-Site groundwater investigation to evaluate the potential risks to downgradient receptors due to the ingestion of groundwater and/or the groundwater volatilization to indoor air pathway.

The off-Site groundwater investigation includes the following general tasks:

- A street level survey will be conducted north of the Site to document the presence of water wells, building construction details, and land use
- Up to five new monitoring wells will be installed north (downgradient) of the Site
- Collection of one groundwater sample from each newly installed well and one field duplicate sample for quality assurance/quality control purposes)
- Chemical analysis of up to six groundwater samples for the presence of volatile organic compounds (VOCs)

A detailed description of each of the general tasks is presented below.

2.0 SCOPE OF WORK

The following subsections describe the off-Site groundwater investigation field activities and data evaluation methodologies.

2.1 STREET LEVEL SURVEY

CRA has been unable to confirm that the all commercial, residential, and vacant properties downgradient of the Site are connected to the public water supply. These Properties of Interest are highlighted on Figure 3. Where possible, without entering private property, CRA will inspect the Properties of Interest south of Powers Street and west of Elliot Street for evidence of a water well.

A street level survey will be conducted north of the Site, south of Powers Street and west of Elliot Street. The building's construction (i.e., basements or slab on grade) and property's land use (i.e., commercial, residential, or vacant) will be recorded.

2.2 INSTALLATION OF GROUNDWATER MONITORING WELLS

Up to four monitoring wells will be installed on City of Muncie (City) property at the closest accessible locations north of the Site (i.e., West 2nd Street), as identified on Figure 3. In addition, one monitoring well will be installed in the north east corner of the Site.

Each borehole will be logged for stratigraphy during borehole advancement. Soils will be screened with a photoionization detector (PID) and examined for visual and olfactory indication of contamination. Soil cuttings generated during monitoring well installation activities will be drummed in Department of Transportation (DOT) approved 55-gallon drums and disposed of in accordance with applicable regulations.

Boreholes will be instrumented as 2-inch monitoring wells. Monitoring wells will be constructed using polyvinyl chloride (PVC) risers and 10-foot long, 0.01-inch slot PVC well screens. Well screens will be set to straddle the water table. A sandpack will be placed to a height of two vertical feet above the top of the screen. A bentonite seal will be placed above the sandpack to within feet of the ground surface. The remaining portion of the unfilled annulus will be filled with concrete and a protective casing will be installed over each well. The riser pipe will be capped with an expandable locking cap. Each monitoring well will be clearly labeled with a unique identification number. The number will be located on the well protector in an area where the number is protected from possible tampering.

Upon installation, the monitoring wells will be monitored for groundwater recovery. Once recovered, the depth to groundwater will be recorded and the well will be developed. Development will consist of removing several well volumes of groundwater until such time as temperature, pH, and conductivity measurements stabilize indicating that the water in the well is representative of the screened hydrogeologic unit. Well development water will be drummed in DOT approved 55-gallon drums and disposed of in accordance with applicable regulations.

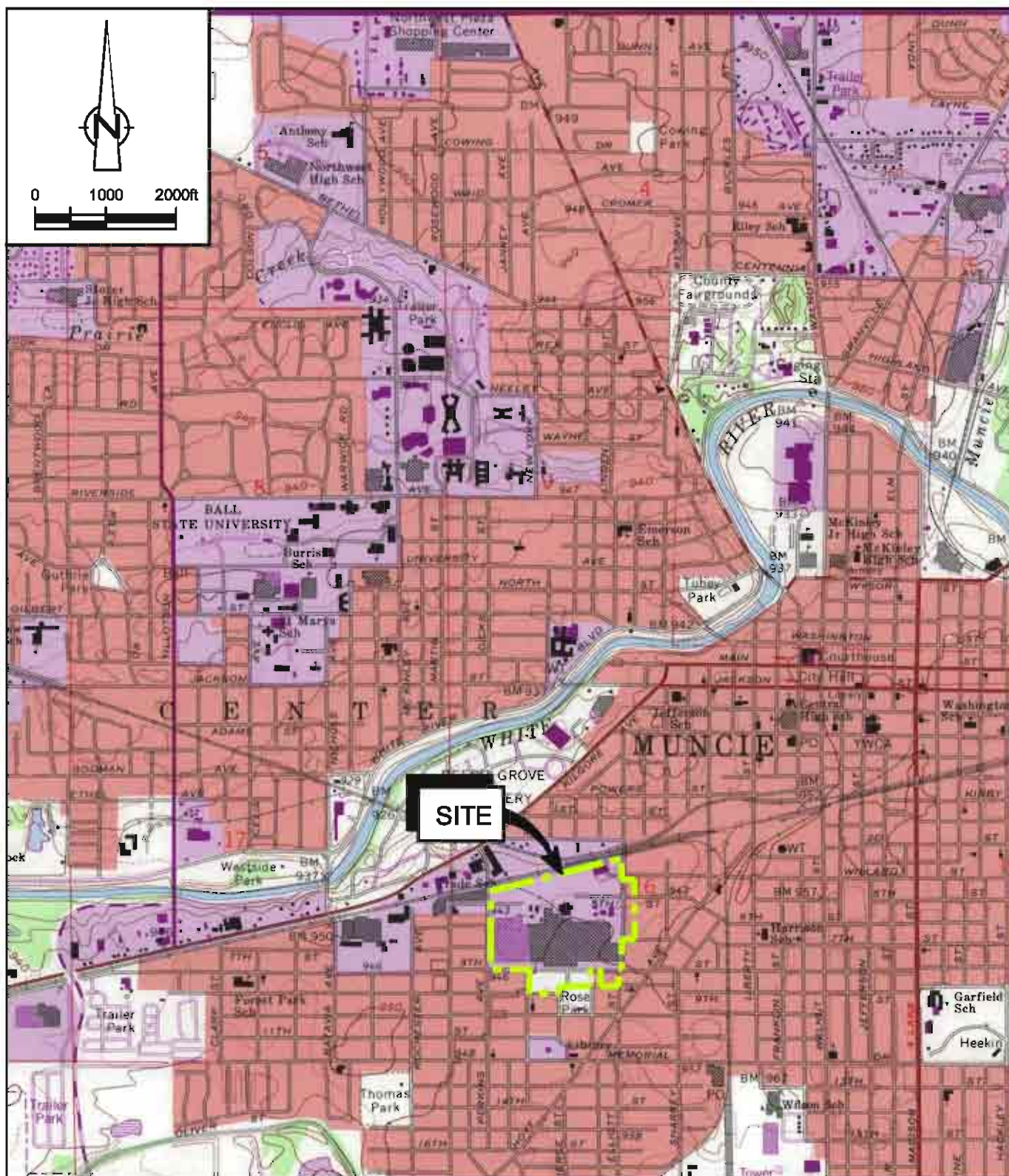
2.3 GROUNDWATER SAMPLING AND ANALYSIS

Low-flow groundwater sampling techniques shall be employed to collect groundwater samples at the newly installed monitoring wells for laboratory analysis of VOCs in accordance with CRA's Standard Operating Procedures (SOPs) for groundwater sampling (Attachment 1). In addition, one field duplicate sample will be collected for quality assurance/quality control purposes.

2.4 DATA EVALUATION

The groundwater quality data will be evaluated with respect to IDEM's RISC Industrial and Residential Default Closure Criteria and IDEM's Groundwater Screening Levels for Chlorinated Compounds as presented in *Draft Vapor Intrusion Pilot Program Guidance* (VIPPG) document dated April 26, 2006.

The results of the off-Site groundwater investigation will be submitted to IDEM in a technical memorandum.



SOURCE: USGS QUADRANGLE MAP;
MUNCIE, INDIANA

LEGEND

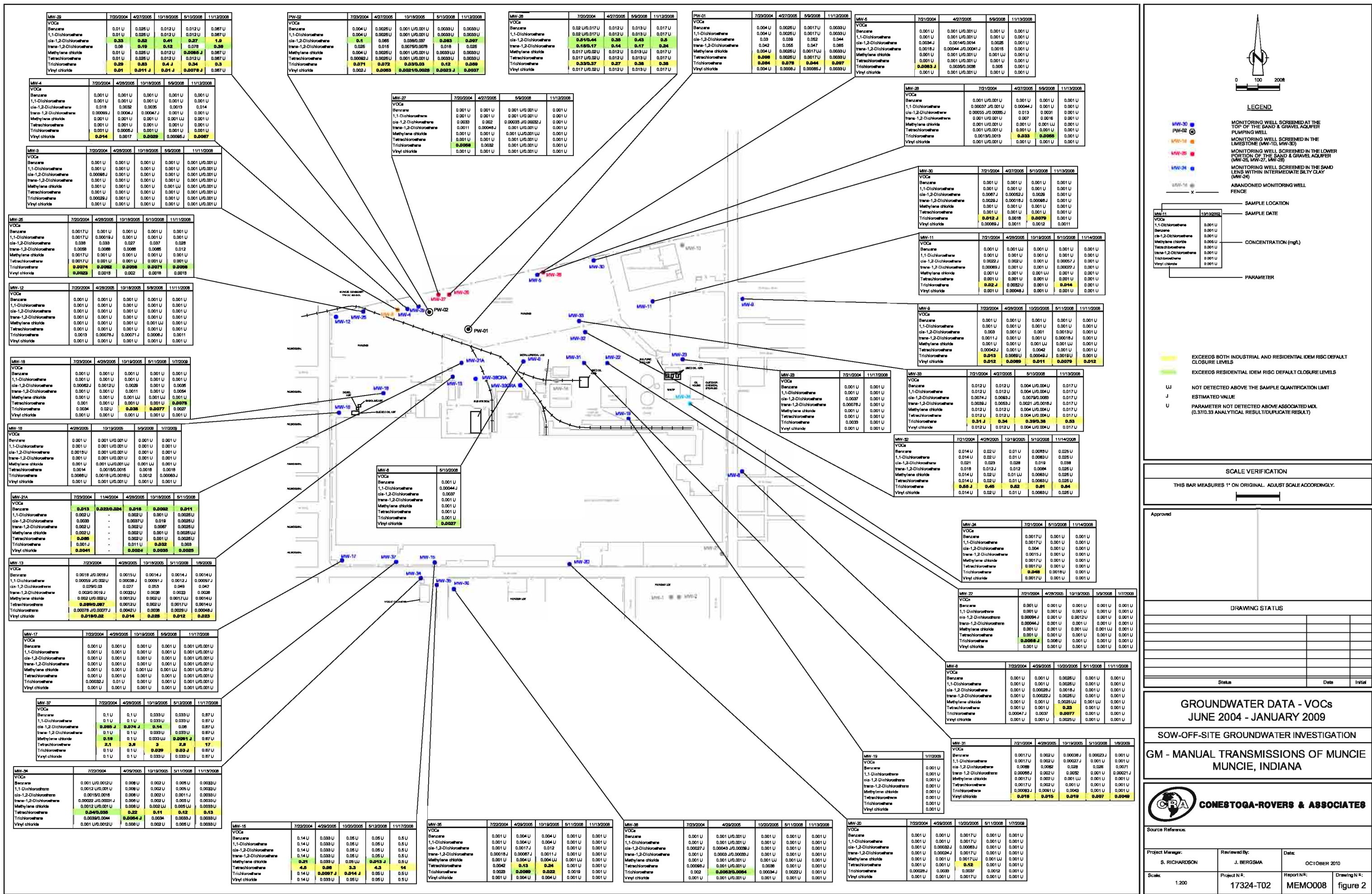
— APPROXIMATE SITE BOUNDARY

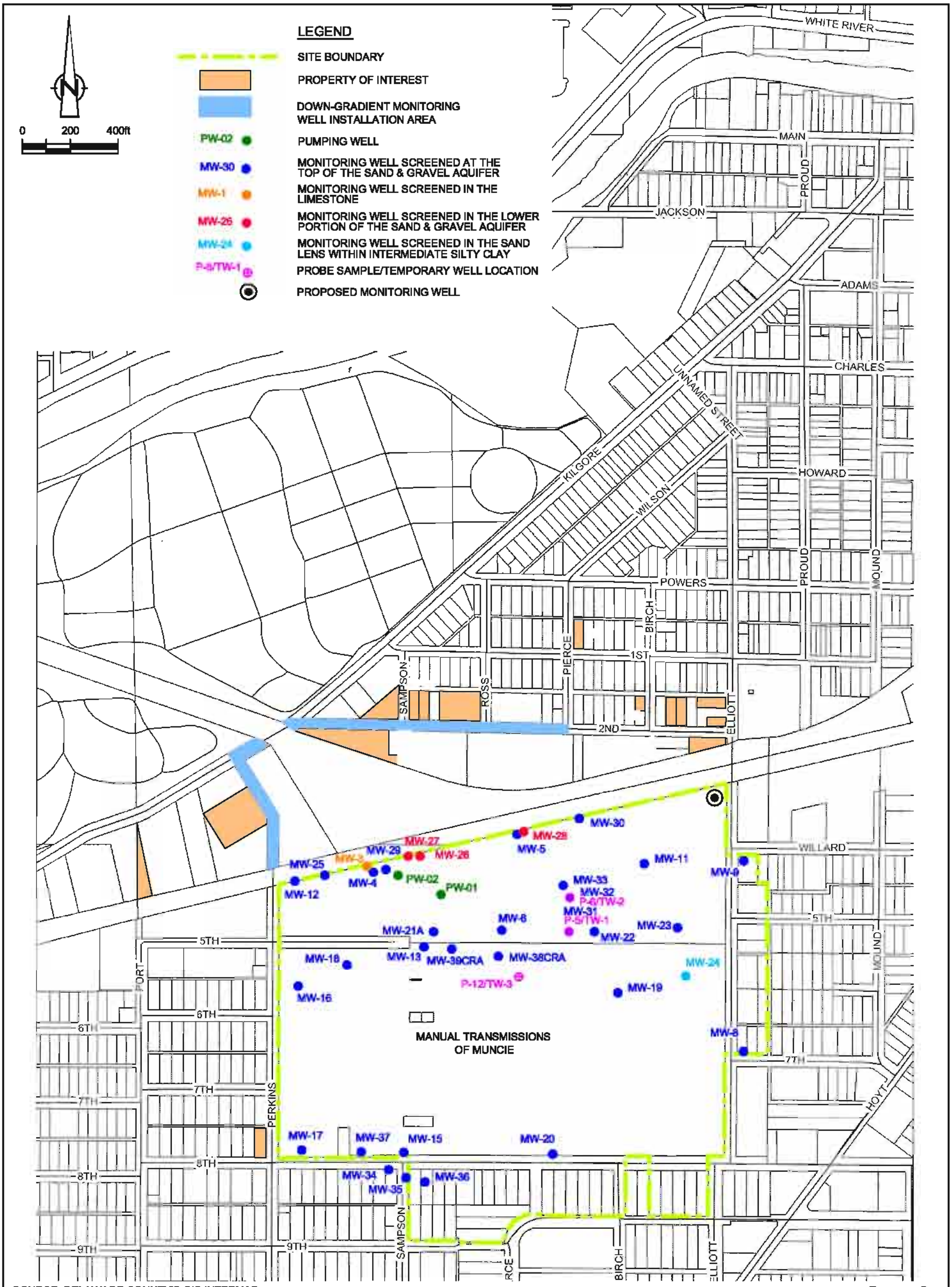
figure 1

SITE LOCATION MAP
OFF-SITE GROUNDWATER INVESTIGATION
FORMER MANUAL TRANSMISSIONS OF MUNCIE
MOTORS LIQUIDATION COMPANY
Muncie, Indiana



MUNCIE





SOURCE: DELAWARE COUNTY'S GIS INTERMAP.

figure 3
SCOPE OF WORK
OFF-SITE GROUNDWATER INVESTIGATION
FORMER MANUAL TRANSMISSIONS OF MUNCIE
MOTORS LIQUIDATION COMPANY
Muncie, Indiana

ATTACHMENT A

STANDARD OPERATING PROCEDURES

CRA FIELD TRAINING MANUAL

SECTION 7.0:

WATER SAMPLING STANDARD OPERATING PROCEDURES

- A. GROUNDWATER**
- B. RESIDENTIAL**
- C. SURFACE WATER**

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Section 7: Water Sampling SOPs
Revision 0 - June 3, 2008

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FIGURE 3.8 TYPICAL GROUNDWATER/RESIDENTIAL WATER SAMPLE LOG ENTRY

LIST OF FORMS

SP-02	PROJECT PLANNING, COMPLETION AND FOLLOW-UP CHECKLIST
SP-05	GROUNDWATER SAMPLING EQUIPMENT AND SUPPLY CHECKLIST
SP-06	WELL DEVELOPMENT AND STABILIZATION FORM
SP-07	WELL PURGING FIELD INFORMATION FORM
SP-08	SAMPLE COLLECTION DATA SHEET - GROUNDWATER SAMPLING PROGRAM
SP-09	MONITORING WELL RECORD FOR LOW-FLOW PURGING
SP-17	EQUIPMENT AND SUPPLY CHECKLIST - SURFACE WATER SAMPLING, SEDIMENT SAMPLING, AND FLOW MEASUREMENT

7.0 **WATER SAMPLING (GROUNDWATER, RESIDENTIAL, AND SURFACE WATER) STANDARD OPERATING PROCEDURES**

7.1 **INTRODUCTION**

Groundwater, residential, and surface water sampling are conducted in order to characterize the groundwater and surface water quality at a site. Standard Operating Procedures (SOPs) are presented herein for the collection of groundwater and surface water samples from:

- monitoring wells;
- residential wells; and
- surface water bodies.

This guideline is not intended to provide the basis for designing a groundwater or surface water monitoring program, but instead assumes that a groundwater and/or surface water monitoring program has already been designed. It is also assumed that a site-specific Work Plan has been established and that a CRA representative is preparing to mobilize to the site.

Groundwater and surface water sampling procedures vary from project to project due to:

- different chemicals of concern;
- different guidance provided by local, provincial/state, and/or federal regulatory agencies with jurisdiction at the site; and
- the specific objectives of the project.

It is essential that all groundwater, residential, and surface water sampling activities conform to local, state/provincial, and federal regulations. Therefore, it is essential that the CRA representative carefully reviews the Work Plan requirements. The primary goal of groundwater, residential, and surface water sampling is the collection of samples representative of the hydrostratigraphic unit and/or surface water body. It is necessary to use appropriate sampling techniques to collect representative samples that provide reliable and reproducible results in accordance with the Work Plan and all relevant regulations.

The remainder of this section is organized as follows:

- Section 7.2 Background
- Section 7.3 Planning and Preparation
- Section 7.4 Safety and Health
- Section 7.5 Quality Assurance/Quality Control
- Section 7.6 Equipment Decontamination
- Section 7.7 Field Procedures for Groundwater Sampling
- Section 7.8 Field Procedures for Residential Sampling

- Section 7.9 Field Procedures for Surface Water Sampling
- Section 7.10 Follow-Up Activities
- Section 7.11 References

7.2 **BACKGROUND**

The objective of a groundwater and residential monitoring program is to obtain samples that are representative of existing groundwater conditions, or samples that retain the physical and chemical properties of groundwater in the hydrostratigraphic unit. Surface water sampling is performed to collect samples that are representative of physical and chemical properties of surface water bodies. Improper sampling and transport practices will cause compounds of interest to be removed or added to a sample prior to analysis. The importance of proper and consistent field sampling methods cannot be over emphasized. It is equally important that proper documentation occurs throughout the sampling program.

The most important aspect of groundwater sampling is the collection of groundwater samples that are free of suspended silt, sediment, or other fine-grained material. Fine-grained material has a variety of chemical compounds sorbed to the particles or has the ability to sorb chemicals from the aqueous phase. This causes a bias in the subsequent analytical results. Reproducible and reliable analytical data are invaluable to a groundwater monitoring program. CRA frequently criticizes the sampling activities completed by others due to the collection and analyses of turbid samples. This SOP discusses sampling protocols that typically achieve sediment-free samples.

When sampling for monitored natural attenuation (MNA) parameters, more stringent protocols are followed to ensure sediment-free samples that are representative of the total mobile load (i.e., dissolved and naturally suspended particles). Low-flow purging (LFP) techniques are strongly recommended, if not mandated, when collecting groundwater samples for MNA parameters. The LFP techniques detailed in Section 7.7.5.3 are in accordance with United States Environmental Protection Agency (USEPA) LFP procedures (Puls and Barcelona, 1996).

Groundwater sampling is required for various reasons, including:

- investigating potable or industrial water supplies;
- tracking contaminant plumes; and
- investigating a site with suspected groundwater contamination.

Groundwater is usually sampled from in-place wells, installed either temporarily or permanently. Municipal, industrial, or residential wells may also be sampled during an investigation. When completing residential well sampling it is important that representative samples are collected. Poor or incorrect sampling techniques will result in erroneous results. Incorrect results disclosed to the public

will create a false impression, making it difficult to change the perception when correct results are reported.

Groundwater and residential sample collection are performed from non-impacted to most impacted locations. This eliminates the potential for cross-contamination. A review of all historical analytical data is performed to ensure the exact sampling sequence.

Surface water sampling locations are selected based on many factors including:

- the study objectives;
- the location of point source discharges;
- the location of no-point source discharges and tributaries;
- the presence of structures (e.g., bridges, dams); and
- accessibility.

Surface water sampling should be performed from downstream to upstream locations. This ensures that surface water sampling activities do not cause suspended sediments to bias samples collected downstream.

7.3 PLANNING AND PREPARATION

Prior to groundwater, residential, and surface water sampling:

1. Review the Work Plan, project documents, and Site-Specific Health and Safety Plan (HASP) with the Project Manager/Coordinator.
2. Review the Quality Assurance Project Plan (QAPP) with the Project Coordinator and Project Chemist to determine Quality Assurance/Quality Control (QA/QC) and decontamination requirements.
3. Complete a Field Equipment Requisition Form (QSF-014). Assemble all sampling equipment and supplies required per the Groundwater Sampling Equipment and Supply Checklist (Form SP-05). The Project Planning, Completion, and Follow-Up Checklist (Form SP-02) should be used for guidance throughout the project.
4. Assemble the site plan, well logs, and previous sampling/purging data required for the sampling event. Determine the exact number and locations of wells to be sampled.
5. Obtain all forms to record purging and sampling activities (Forms SP-06, SP-07, SP-08, and SP-09).
6. Confirm with the Project Manager/Coordinator that a Property Access/Utility Clearance Data Sheet (QSF-019) has been completed. For residential sampling, ensure that homeowners have been notified of the intended sampling event. Confirm the presence of any dogs on site, modify the site-specific Job Safety Analysis, if there is a dog.

7. Arrange access to the site. Obtain all well and site keys. Consider site access conditions (e.g., snow).
8. For surface water sampling consider if hazards exist due to deep/fast moving water, difficult access, and if additional CRA personnel are required for safety and health reasons.
9. For residential sampling contact homeowners to make arrangements for a site visit, arrange for site dog to be removed from all areas where a CRA employee will be working. The client of another party may be responsible for making arrangements.
10. Complete a Vendor Evaluation Form (QSF-012) and file in the Project file for any Vendors that do not have full approval status or are not listed on the Approved Vendor List (QSL-004). Completion of a Safety and Health Schedule (QSF-030 for Canadian work; QSF-031 for U.S. work) is necessary for all Vendors who complete field services. Prior to mobilization on site, the Vendor must submit the form to the Regional Safety and Health Manager for review and approval (if not already posted on QSL-004).
11. Contact the CRA Chemistry group to arrange:
 - SSOW (Simplified Scope of Work);
 - laboratory;
 - sample containers delivery;
 - preservatives if required;
 - filtration information if required;
 - coolers;
 - shipping details;
 - sample starting date; and
 - expected duration of sampling program.
12. If several sampling events are planned, evaluate with the client the benefit of purchasing and installing dedicated sampling equipment. Dedicated purging and sampling equipment reduces potential cross-contamination and reduces decontamination requirements. At a minimum, sample tubing is dedicated to each well and is left secured in the well for future use. For LFP it is recommended that each well is dedicated with a bladder pump and tubing to eliminate well disturbance.
13. Evaluate sample notification needs with the Project Coordinator. Have the regulatory groups, client, landowner, CRA personnel, and laboratory been notified of the sampling activities?
14. Evaluate containment and disposal requirements for purge waters.
15. Plan sampling activities to ensure that wells that historically go dry or have poor recharge fit into the sampling program. This will reduce the time required for sample collection.
16. Plan the sequence of sampling activities to reduce the potential for cross-contamination. For groundwater sampling, start with clean wells and progress to impacted wells. For surface water sampling, start downstream and progress upstream.

CRA is committed to conducting field activities in accordance with sound safety and health practices. CRA adheres to high safety standards to protect the safety and health of all employees, subcontractors, customers, and communities in which they work. The safety and health of our employees takes precedence over cost and schedule implications.

Field personnel are required to implement the Safety Means Responsibility Awareness Teamwork (SMART) program as follows:

- Assure the HASP is specific to the job and approved by a Regional Safety & Health Manager.
- Confirm that all HASP elements have been implemented for the job.
- A Job Safety Analysis (JSA) for each task has been reviewed, modified for the specific site conditions, and communicated to all appropriate site personnel. The JSAs are a component of the HASP.
- Incorporate Stop Work Authority; Stop, Think, Act, Review (STAR) process; Safe Task Evaluation Process (STEP); Observations process; Near Loss and Incident Management process in the day-to-day operations of the job.
- Review and implement applicable sections of the CRA Safety & Health Policy Manual.
- Confirm that all site personnel have the required training and medical surveillance as defined in the HASP.
- Be prepared for emergency situations, locating safety showers, fire protection equipment, evacuation route, rally point, and first aid equipment before you begin working, and make sure that the equipment is in good working order.
- Maintain all required Personal Protective Equipment (PPE), safety equipment, and instrumentation necessary to perform the work effectively, efficiently, and safely.
- Be prepared to call the CRA Incident Hotline at 1-866-529-4886 for all involving injury/illness, property damage, vehicle incident, and/or significant Near Loss.

It is the responsibility of the Project Manager to:

- Ensure that all CRA field personnel have received the appropriate health and safety and field training and are qualified to complete the work.
- Provide subcontractors with a Job Hazard Analysis to enable them to develop their own HASP.
- Ensure that all subcontractors meet CRA's (and the Client's) safety requirements.

7.5 QUALITY ASSURANCE/QUALITY CONTROL

A well-designed QA/QC program will:

- ensure that data of sufficient quality are obtained, for proper site management decisions or remediation design;
- allow for monitoring of staff and contractor performance; and
- verify the quality of the data for the regulatory agency.

It is important to note that a QA/QC program should be developed on a site-specific basis. QA/QC requirements are discussed in Section 3.9.

7.6 EQUIPMENT DECONTAMINATION

Equipment decontamination procedures for a groundwater, residential, or surface water monitoring program will be described in detail in the site-specific Work Plan or in the QAPP.

Equipment is decontaminated between sampling locations and prior to leaving the site. Upon completion of the sampling program, all equipment is decontaminated at the site and then returned clean to the appropriate field equipment manager.

For most groundwater, residential, and surface water sampling programs, sampling equipment (e.g., pumps, bailers, water level indicators) is typically cleaned as follows:

1. Wash with clean potable water and laboratory detergent, using a brush as necessary to remove particulates.
2. Rinse with tap water.
3. Rinse with deionized water.
4. Air dry for as long as possible.

If required, the following steps may be added when sampling for Volatile Organic Compounds (VOCs) and metals:

1. Rinse with 10 percent nitric acid (only if samples are to be analyzed for metals).
2. Rinse with deionized water.
3. Rinse with appropriate solvent (pesticide grade isopropanol, methanol, acetone, hexane, if required).
4. Rinse again with deionized water.
5. Air dry for as long as possible.
6. Wrap samplers in aluminum foil to prevent contamination.

Caution: Check the QAPP to confirm the cleaning protocol. Use of incorrect cleaning protocol could invalidate chemical data.

7.6.1 PURGE WATER AND DECONTAMINATION FLUID DISPOSAL

Project-specific disposal methods for purged groundwater and decontamination fluids are determined by the Project Manager during the sampling program's planning and preparation stage (see Section 7.3), but may include:

1. Off-site treatment at private treatment/disposal facility or publicly owned treatment facilities (sanitary sewer).
2. On-site treatment at a client-operated facility.
3. Direct discharge to the surrounding ground surface, allowing infiltration to the underlying subsurface.
4. Direct discharge to an impervious pavement surface allowing for evaporation.

Options 3 and 4 are permitted only after careful review of these practices and the anticipated site conditions. Under no circumstances shall CRA personnel aggravate an existing condition or spread contamination into clean areas.

Decontamination fluids (specifically cleaning solvents/acids) are segregated and collected separately from wash water and purge water. Often small volumes of solvents used during the course of a groundwater, residential, or surface water sampling program will evaporate if left in an open pail. If evaporation is not possible, off-site disposal need to be arranged.

7.7 FIELD PROCEDURES FOR GROUNDWATER SAMPLING

The typical series of events that takes place for a groundwater sampling program is:

1. Well identification and inspection.
2. Air monitoring.
3. Water level monitoring.
4. Well depth sounding.
5. Well volume calculation.
6. Purging and sampling equipment installation.
7. Well purging and stabilization monitoring.
8. Sample collection, sample preparation, completion of chain-of-custody, (COC) sample packaging.

9. Final water level monitoring (if required), purging, sampling equipment removal, secure the well.
10. Equipment decontamination.
11. Field note completion and review.
12. Sample shipment and COC distribution.
13. Purged groundwater and decontamination fluid disposal.
14. Sample record documentation, equipment return.
15. Completion and distribution of appropriate forms.

It is recommended that new plastic sheeting be placed on the ground around the well to prevent contamination of purging and sampling equipment and accessories (e.g., pumps, hoses, rope.).

7.7.1 WELL IDENTIFICATION AND INSPECTION

At sites with numerous wells or wells nests, misidentification of wells has occurred. The CRA representative must be alert to the possibility of potential cap switching, mislabeled wells, or unlabeled well locations.

Determine proper well location and identification by comparing the well log details to the measured well depths (i.e., total well depth, casing diameter, casing stick-up, or stick-down distances), field tie-ins, and site plan.

Once well identification has been established, complete a thorough well inspection:

1. Determine if the well cap and lock are secure, and check for vandalism.
2. If no lock is present, dedicate a new lock to the well location.
3. Examine the integrity of the surface seal.
4. Check for cracks, evidence of frost heave, or subsidence in the vicinity of the well.
5. Examine the integrity of the protective casing. Ensure that the casing can be closed and locked.
6. If required, re-label the well to assist in future identification.
7. If the well is installed with dedicated sampling equipment, check for cracks or leaks in tubing, and worn or frayed rope.
8. Record all the well inspection details in the field book to document well conditions and suitability for groundwater sampling activities.
9. Forward the well inspection results to the Project Coordinator, especially if repairs are required.

7.7.2 AIR MONITORING

Prior to removing a well cap, measure the breathing space above the well with a photoionization detector (PID) to establish background of undifferentiated organic vapor levels. Repeat this process once the well cap has been removed. If either of the PID levels exceed the air quality criteria established in the HASP, air-purifying respiratory (APR) protection or a supplied air system is required. Also take a PID reading inside the riser pipe. This PID reading is a good indication of elevated chemical or non-aqueous phase liquids (NAPL) presence. Report all elevated PID levels to the Project Coordinator immediately to determine if additional health and safety and personnel protective equipment is required. The HASP will provide the required action levels and PPE.

7.7.3 WATER LEVEL MONITORING/WELL DEPTH SOUNDING

Prior to commencing well purging and groundwater sampling, the water level is measured for hydraulic monitoring and to determine the well volume. Typically, a complete round of water level measurements is taken at a site to establish groundwater conditions prior to initiating well purging or groundwater sampling activities.

A watertight cap provides an airtight seal on the casing and the water level positioned in the casing area. The cap creates a vacuum or pressurized condition in the casing section which can support or depress the water column in the well casing. This can produce an artificially high or low water level in the well casing. This effect can cause a few inches or feet of error in the static water level. Once the cap is removed, allow the pressure to stabilize for about a half hour. Measure the water level frequently to ensure that stabilization of the water level has occurred. Once the water level has stabilized (i.e., is static) the correct water level may be measured.

A number of instruments are available to measure groundwater levels. CRA typically uses:

- battery-operated water level indicators (i.e., audible and/or visual identification of water level);
- battery-operated oil/water interface probes (i.e., audible and/or visual identification of water levels and presence of NAPL);
- electronic transducers (numerous manufacturers) and recording devices for long-term hydraulic monitoring; and
- Stevens™ recorders (both float and electronic instrumentation) for long-term hydraulic monitoring.

Section 8.0 describes in detail the equipment and monitoring techniques for water level measurements.

Well depth sounding is often required to confirm well identification, evaluate the accumulation of sediment in the well bottom, or assist in determining the standing well volume. Sounding is performed using a water level indicator or a measuring tape with a weighted end. The water level indicator or weighted tape is lowered to the bottom of the well and a comparison is made of the installed well depth

versus the measured well depth. The presence of excessive sediment or drill cuttings may warrant redevelopment of the well prior to well purging and groundwater sampling activities.

The total well depth is compared to the original installed total well depth. If the well screen is more than 50 percent blocked by accumulated sediment, the well is redeveloped prior to the next groundwater sampling event. Report all wells requiring redevelopment to the Project Coordinator. Well depth sounding is performed on an annual or biannual basis if the well is equipped with a dedicated pump.

For LFP, well depth measurement is performed to ensure proper pump intake placement. The use of a wide-based probe, such as a weighted tape, is necessary to minimize penetration and disturbance of accumulated sediment. The measuring device is lowered slowly through the water column to the well bottom to minimize mixing of the stagnant well casing water and disturbance of sediment.

Note: Don't forget that decontamination procedures apply to the water level monitoring equipment as well as the groundwater sampling equipment. If well sounding is performed, the entire measuring device must be thoroughly decontaminated prior to re-use. Measuring the well depth with certain water level indicators may damage the probe seal. Therefore, a tape with a weighted end should be used to measure well depth.

7.7.4 WELL VOLUME CALCULATION

Prior to commencing well purging, the volume of water in the well must be known to determine the volume of groundwater to be removed. A well volume is defined as the volume of water contained in the well screen and casing (and in the case of an open bedrock hole, the volume of water in the open corehole and possibly in the well casing). To determine the standing water volume in a well:

1. Calculate the distance from the bottom of the well to the static water level.
2. Measure the inside diameter of the well or casing. Obtain the volume of standing water in the well using the following formula:

$$V = \pi r^2 h \text{ (7.48 U.S gallons/cubic feet) (1 liter/1,000 cubic centimeters)}$$

where:

V = volume of water in gallons or liters

π = 3.142

r = radius of well casing (feet or meters)

h = depth of water column in the well (feet or meters)

<i>Typical 1-Foot Casing Volumes</i>	
<i>Diameter (inches)</i>	<i>Gallons (U.S.) of Water Per Foot of Casing</i>
1.5	0.09
2	0.16
3	0.37
4	0.65
6	1.47

<i>Typical 1 Meter Casing Volumes</i>		
<i>Diameter</i>		<i>Litres per Meter of Casing</i>
<i>(inches)</i>	<i>(cm)</i>	
1.5	3	1.14
2	5	2.02
3	8	4.56
4	10	8.11
6	15	18.24

7.7.5 WELL PURGING AND STABILIZATION MONITORING

7.7.5.1 TYPICAL METHOD

Prior to initiating groundwater sample collection, the wells is purged of the standing stagnant groundwater volume. This volume is not representative of the groundwater in the hydrostratigraphic unit. Purging is performed until the water in the well is representative of the actual conditions in the hydrostratigraphic unit. Stabilization is usually achieved by the removal of three to five times the volume of standing water in the well (USEPA convention). Purging is considered complete once purged groundwater is free of sediment and field parameters including pH, specific conductance, temperature, and turbidity are stable. Stabilization is achieved when field measurements for pH, specific conductance, and temperature are within a range of plus or minus 10 percent for three consecutive readings. Field measurement for pH should be within 1 pH of the last three value averages, and groundwater turbidity values should be less than 5 nephelometric turbidity units (NTU) (guidance value only). Once the number of well volumes required to achieve stabilization is established, the volume required to reach stabilization for future sampling events is reduced or eliminated. Extended purging of a well will generally result in achieving sediment-free groundwater conditions.

During purging, if stabilization has not occurred after removal of five well volumes, purging is continued until ten well volumes have been removed. If stabilization still has not been achieved, stabilization may be dropped as a pre-condition to groundwater sampling. The Project Coordinator should be notified that stabilization has not occurred after the removal of ten well volumes.

At high yielding wells, removing three to five well volumes is usually sufficient prior to initiating groundwater sampling. For low yield wells (i.e., wells that pump dry after one well volume) it is necessary to purge the well dry on three successive days, unless the well recovers to full static conditions in a shorter time. If the recharge is relatively high, groundwater sampling will be initiated once the well has fully recovered to static groundwater conditions, or to a level that is sufficient to collect the necessary groundwater sample volume.

Note: Purging of dry wells should be scheduled to begin on Monday or Tuesday, to reduce weekend requirements.

Turbidity of purged groundwater is evaluated by a visual examination for sediment/silt presence or by using a nephelometer which physically measures groundwater turbidity in NTUs. Generally, a turbidity value of 50 NTU or less is acceptable, although some regulatory agencies have established lower criteria (i.e., less than 5 NTU). If 50 NTU is not achieved, filtration of samples may be required. LFP can generally result in turbidity values less than 5 NTU.

Note: Agitation of the water column within the well will increase turbidity. Therefore, bailers and inertia pumps (Waterra™) are of limited use for collecting sediment-free samples. The tubing of peristaltic pumps must be secured to prevent movement of the tubing within the water column which would disturb sediment. The best method to reduce sediment disturbance is low-volume non-agitation pumping (i.e., bladder pump).

Well purging is accomplished using dedicated equipment or by using either peristaltic, bladder, or other approved purging methods. Purging and sampling equipment are dependent on the total well depth. Bailing can be used for well purging but this method stirs up sediment and increases the purging effort required before stabilization is achieved. Equipment available for well purging is discussed in Section 7.7.7. Monitoring equipment used during well purging includes a water level indicator, pH meter, thermometer, conductivity meter, and turbidity meter.

7.7.5.2 PURGING ENTIRE WATER COLUMN

The purging equipment is lowered into the top of the standing water column. Well purging is completed from as close to the top of the water column as possible, not from the well bottom, unless poor well recovery occurs. Purging from the top of the water column moves water from the formation through the well screen of the well and into the well casing. This allows for the entire static volume to be removed. Purging at depth in the water column does not remove water above the pump intake and results in the collection of unrepresentative samples.

If required, the pump intake can be adjusted. If the recovery rate is greater than the pumping rate, the pump should remain suspended until the required purged volume has been removed. If the recovery rate is less than the pumping rate, the pump should be lowered to ensure the removal of the required well volume.

7.7.5.3 LOW-FLOW PURGING (LFP) TECHNIQUE

LFP purging results in minimal drawdown during well purging, so less purging is required before formation water is removed. The volume required for purging using LFP is significantly reduced. LFP results in less agitation and mobilization of sediments compared to traditional sampling techniques.

A pre-cleaned stainless steel bladder pump equipped with a Teflon™ bladder is strongly recommended for LFP. The discharge line should be polyethylene or Teflon™ lined tubing with an inside diameter of 1/4 or 3/8 inch (6 or 10 mm). Check the Work Plan or QAPP to ascertain the proper bladder and discharge tubing. Smaller discharge tubing ensures that the tubing remains filled with water and reduces air bubbles at low purging rates. The airline to the pump is generally 1/4-inch (6 mm) inside diameter polyethylene tubing. The pump is secured to nylon rope and positioned in the well so that the pump intake is set at the mid-point of the well screen, or a minimum of 2 feet (0.6 m) above the bottom of the well or accumulated sediment level. It is important that the rope, airline, and discharge tubing are measured prior to installation in the well. The bladder pump and tubing are lowered very slowly through the water column to minimize mixing of the stagnant well casing water and to minimize the agitation of sediment into suspension, which would increase the purging time. It is recommended, and in some instances regulated, that pump installation occurs at least 24 hours prior to initiating LFP. It is recommended that a bladder pump be dedicated to the well for regular monitoring events.

During LFP, the pumping rate should be between 100 and 500 milliliters per minute (mL/min). It is recommended that initial pumping be conducted at a lower rate to limit drawdown in the well. During purging, groundwater levels are measured to maintain a maximum 0.4 foot (0.1 m) of drawdown. The pumping rate can be gradually increased during LFP. Pumping rate increases will be dependent on the drawdown and the stabilization of field parameters discussed below. Pumping rate adjustments should occur in the first 15 minutes of purging. After this time the pumping rate should remain constant and flow rate adjustments should be avoided. During purging, the pumping rate and groundwater level should be measured at least every 10 minutes. It is recommended that water level measurements occur at 5-minute intervals.

During LFP, stabilization of the purged groundwater is required to ensure the collection of representative groundwater samples from the formation and not from the stagnant water in the well casing. Field parameters including pH, temperature, specific conductance, oxidation-reduction potential (ORP), dissolved oxygen (DO), and turbidity should be monitored during LFP. The measurement of these field parameters is used to evaluate if stabilization of the purged groundwater has occurred prior to the collection of groundwater samples. The field measurements should be measured and recorded at 5-minute intervals. Groundwater stabilization is considered achieved when three consecutive readings for each of the field parameters, taken at 5-minute intervals, are within the following limits:

- pH ± 0.1 pH units of the average value of the three readings;
- temperature ± 3 percent of the average value of the three readings;

- conductivity ± 0.005 milliSiemen per centimeter (mS/cm) of the average value of the three readings for conductivity < 1 mS/cm and ± 0.01 mS/cm of the average value of the three readings for conductivity > 1 mS/cm;
- ORP ± 10 millivolts (mV) of the average value of the three readings;
- DO ± 10 percent of the average value of the three readings; and
- turbidity ± 10 percent of the average value of the three readings, or a final value of less than 5 NTU.

During LFP, field parameters are measured using a flow-through cell apparatus. At the start of LFP the purge water is visually inspected for clarity prior to connecting to the flow-through cell. If the purge water is turbid, LFP continues until the purge water is visually less turbid prior to connecting to the flow-through cell. Field parameters may be obtained using individual meters or a multiple meter unit; however, the use of a flow-through cell is highly recommended. All meters must be calibrated daily in accordance with the manufacturer's and CRA's calibration instructions, and a calibration record maintained in a standard CRA field book.

During LFP the meter readings are monitored for evidence of meter malfunction. The following are common indicators of meter malfunctions:

- DO above solubility (e.g., oxygen solubility is approximately 11 milligrams per liter (mg/L) at 10°C) may indicate a DO meter malfunction;
- negative ORP and DO less than 1 to 2 mg/L may indicate either an ORP or a DO meter malfunction (i.e., should have positive ORP and DO less than 1 to 2 mg/L under oxidizing conditions); and
- positive ORP and DO less than 1 mg/L may indicate either an ORP or a DO meter malfunction (i.e., should have a negative ORP and DO less than 1 mg/L under reducing conditions).

Meter calibration fluids should be available for meter recalibration in the field. Spare meters should also be available for meter replacement if necessary.

<i>Note: DO levels exceeding the solubility of oxygen in water are erroneous and are indicative of meter malfunction or poor sampling techniques causing turbulence and aeration. DO concentrations cannot exceed:</i>			
<i>9 mg/L at 20 °C</i>	<i>10 mg/L at 15 °C</i>	<i>11 mg/L at 10 °C</i>	<i>14 mg/L at 1 °C</i>

Stabilization will be considered complete when the field parameters have stabilized as indicated in the above table. Purging will continue if stabilization does not occur, until a maximum of 20 screen volumes has been removed. LFP causes groundwater to be drawn from a significant distance above or below the pump intake. Therefore, the screen volume is based on a 5-foot (1.5 m) screen length. After the removal of 20 screen volumes, purging will continue if the purged water remains visually turbid and appears to be clearing. Also purging will continue if the field parameters vary only slightly outside of the stabilization criteria and appear to be approaching stabilization.

If the recharge to the well is insufficient to conduct LFP, the well should be pumped dry and allowed to recharge sufficiently for the collection of the groundwater sample volume. Wells purged dry are required to meet the stabilization criteria detailed above.

7.7.5.4 SAMPLING TECHNIQUES

Upon completion of purging, with groundwater stabilization and clarity meeting the applicable protocol described above, groundwater sample collection can proceed. Generally the field parameters of pH, temperature, and specific conductance are monitored first, then any other required field measurements.

Samples are collected directly from the purging pump, when possible, or an alternate device (i.e., pump or bailer) may be installed or used. If new sampling equipment is installed, the first few bails or discharge volumes should be discarded to allow acclimation of the sampling equipment with the groundwater.

Samples are typically collected from the pump or bailer with the discharged groundwater collected directly in the appropriate sample containers. The interior of the bottle or cap must not be touched or handled in anyway. New gloves (i.e., disposable nitrile gloves or equivalent) should be worn for the collection of each sample. Caps from sample bottles must not be placed on the ground or in pockets to eliminate the possibility of cross-contamination.

Descriptions of the various equipment and sampling methods for the collection of groundwater samples are contained in Section 7.7.7.

The following describes the main activities involved in the collection of groundwater samples.

7.7.5.5 ORDER OF SAMPLE COLLECTION

Groundwater samples are collected and containerized in the order following volatilization sensitivity:

1. VOCs.
2. Semi-volatile organic compounds (SVOCs).
3. Total organic carbon.
4. Total organic halides.
5. Extractable organics.
6. Total metals.
7. Dissolved metals.
8. Phenols.
9. Cyanide.

10. Sulfate and chloride.
11. Nitrate and ammonia.
12. Microbiological parameters.
13. Radionuclides.

QA/QC requirements for groundwater sampling are described in detail in Section 3.9.

7.7.6 SAMPLE ACQUISITION AND TRANSFER

If groundwater sample collection is performed using a pump, the flow rate must not exceed 100 mL/min during the collection of groundwater samples for VOCs. The low flow rate will reduce the possibility of degassing samples. During the collection of groundwater into the sample container or filtration device, minimize agitation and aeration of the sample. Groundwater samples are transferred directly into the sample container for submittal to the laboratory. Groundwater samples should not be collected in larger containers and subsequently transferred to smaller sample containers; however, on occasion this will be required for filtration or sample composting. During VOC sample collection, samples must not be collected, handled, or containerized near or in the vicinity of a running motor or exhaust which may contaminate the samples.

Groundwater samples for VOCs are collected in laboratory supplied 40 mL glass vials. The vials are filled to the top until a meniscus is formed, then topped with a Teflon™-lined cap. To prevent the loss of volatiles, it is important that no air bubbles or headspace are present in the sample container. Inverting and tapping the vial will check for the presence of air bubbles. If air bubbles are present, the sample should be topped off again and resealed. This process may only be performed a maximum of twice, at which time the sample must be discarded and the sample retaken. If preservatives were present in the bottle from the laboratory, a new sample vial must be used.

<i>Note: Gas bubbles that appear in VOC containers after sample collection may be a result of degassing or reaction with preservative. If this occurs, note this occurrence on the chain-of-custody. Re-sampling is not required in most cases.</i>
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During sample collection ensure groundwater samples are preserved according to laboratory requirements. If required and supplied by the laboratory, preserve the samples in accordance with the QAPP. Some laboratories pre-preserve bottles so that once the groundwater sample is added the preservation is completed. In either case, it is advisable to check sample preservation using litmus paper. Using litmus paper ensures that groundwater sample preservation has been completed to the proper pH as required by the QAPP. If preservation of a sample does not meet the requirements of the QAPP, it may be necessary to add additional preservative, or note on the chain-of-custody that incomplete sample preservation has occurred.

Once sample collection is complete, samples are placed in a cooler on ice to maintain a sample temperature no more than 4°C.

7.7.6.1 SAMPLE LABELS/SAMPLE IDENTIFICATION

Label all groundwater samples with the following, written in indelible ink

1. A unique sample number (see Section 3.9 for guidance).
2. Date and time.
3. Parameters to be analyzed.
4. Job number.
5. Sampler's initial.

Secure the label to the bottle. It is recommended that bottle labels be covered with wide clear tape to protect the label during sample packing and shipment. Pack glassware in appropriate packing material to deter breakage during sample packing and shipment. Sample labels can be prepared in advance in CRA offices that have label-generating programs.

An example of a groundwater sample log entry is provided on Figure 3.8.

Section 3.9 details sample labeling requirements for environmental sampling programs. Section 3.9 also details COC requirements and sample shipment requirements.

7.7.7 PURGING/SAMPLING EQUIPMENT

CRA maintains a wide variety of purging and sampling equipment for well purging and groundwater sample collection. The groundwater sampler should be familiar with purging and sampling equipment and understand equipment limitations and proper use. Some equipment is very useful for well purging (i.e., high flow rates) but is not permissible for LFP or for sampling sensitive parameters (e.g., VOCs cannot be collected with a submersible (turbine) or suction pump). If the groundwater sampler understands the various equipment operation and limitations, the proper selection of purging and sampling equipment is made, which will minimize the purging and sampling duration and maximize productivity.

Caution: Gas powered equipment requires special attention to ensure that staff hauling these units do not cause equipment or sample contamination. Frequent changes of disposable glove as well strict separation of sampling crew tasks (i.e., those handling pumps and hoses do not contact generator or are involved in any refueling activities) are required.

The following subsections describe the equipment available for groundwater sampling, the equipment use, approximate flow rates, and advantages and disadvantages of the equipment.

7.7.7.1 PERISTALTIC PUMPS

A peristaltic pump is acceptable for purging wells and for most groundwater sample analytes. The groundwater sampler must ensure that a peristaltic pump is acceptable to regulatory agencies with local jurisdiction for VOC and SVOC sample collection. The QAPP will provide sampling requirements.

A peristaltic pump is capable of lifting water from a maximum depth of 25 feet (7.6 m) below ground surface or the pump, whichever is greater. A peristaltic pump is a self-priming, low volume, suction pump which consists of a rotor with ball bearing rollers. Flexible silicon tubing is inserted around or in the pump rotor and squeezed in place by the heads as they revolve in a circular pattern. The section of silicon tubing must not exceed 3 feet (0.9 m) in length. Additional rigid polyethylene or Teflon™ tubing is attached to the flexible tubing and placed in the well. Another piece of rigid tubing is attached to the discharge end of the flexible silicon tubing to facilitate sample collection. The entire length of rigid and flexible silicon tubing is dedicated to the well for future use. The tubing is typically tied and suspended in the well. The flexible or rigid tubing is not reused in other wells because cross-contamination will occur.

<i>Note: Often a length of tubing is accidentally dropped into a well and can be difficult to retrieve. Retrieval can be accomplished by sending another piece of tubing down the well overlapping the lost section of tubing. Once in place, rotate the tubing, essentially wrapping or corkscrewing the lost tubing and new tubing together. After a number of turns are completed pull the tubing, hopefully with the lost section wound around the new piece. Repeat the procedure until successful.</i>

Liquid is pulled into the tubing by the peristaltic pump through the creation of a vacuum as the rotor head turns. An advantage of using a peristaltic pump is that no pump parts come in direct contact with the sample. A peristaltic pump is capable of providing low flow sampling rates (i.e., typically less than 500 mL/min) with less agitation than other suction pumps. However, it is important that the tubing is secured during pumping to prevent the tubing from moving and causing agitation. A peristaltic pump also allows for regulation of the flow rate by increasing or decreasing the rotor head speed.

Peristaltic pumps are small and easily mobilized to remote sample locations. They require minimal setup, and do not require decontamination between sample locations. The disadvantages of a peristaltic pump are its limited lift and flow capabilities and the limited ability to collect VOC and SVOC samples. If VOC or SVOC sampling, check the QAPP to see if sampling with a peristaltic pump is allowed. Also check with regulatory agencies with local jurisdiction to see if the use of a peristaltic pump for collection of VOC and SVOC samples is acceptable. If using a peristaltic pump for purging, and the collection of VOCs and SVOC samples with the peristaltic pump is not acceptable, it is common to collect the initial VOC and SVOC analytes with a stainless steel bottom loading bailer. The peristaltic pump can then be used to collect the remaining sample analytes.

Peristaltic pumps are becoming more popular for LFP. However, it should be noted that a peristaltic pump may cause degassing, pH modification, and possible VOC loss.

7.7.7.2 SUCTION PUMPS

A number of suction pumps (e.g., centrifugal) exist that can be used for purging applications only. A suction pump draws water through a suction line by creating a vacuum in the suction line or hose. Once drawn into the pump, the groundwater comes into direct contact with the pump rotor/pumping chamber area and it is therefore undesirable for groundwater sampling due to high groundwater agitation. Decontamination of suction pumps is extremely difficult. As with peristaltic pumps, most suction pumps have a limited lift capability of about 25 feet (7.6 m). Larger suction pumps, like 2-inch (5 cm) trash pumps, can achieve high flow rates under low hydraulic head. Flow rates of 15 to 20 U.S. gallons per minute (USgpm) [57 to 76 liters per minute (L/min)] can be achieved. This high flow rate minimizes purging time. New or dedicated suction line should be used at each well if a suction pump is used for purging.

Large suction pumps are also useful for well development, in conjunction with agitation and surging.

Large suction pumps are not suited for LFP due to degassing, pH modifications, VOC loss, and lack of flow adjustment.

Caution: *The groundwater sampler must prevent the siphoning of purged water from a bulk container back into the well. For example, the following scenario is possible: Joe Sampler has completed purging well 'xyz' and has turned off the 2-inch trash pump. The trash pump discharge line is inserted into a wastewater tank and is submerged below the tank water level. As Joe prepares his glassware and sample pump, the wastewater tank contents are siphoned back into the well. This can result in cross contamination with water from other sites/wells which have been purged either:*

- *into the tank,*
- *through the pump, or*
- *through the discharge line.*

All discharge lines/groundwater purge pumps must be provided with a check valve to prevent this situation.

Drilling rig pumps including Moyno, progressive cavity, bean, and mud pumps can be used for well purging and well development.

Suction pumps are a useful tool for high rate purging and well development. They require no additional equipment other than a suction line and discharge line for each well. They are mobile and easily transported around and between sites. Suction pumps are limited to use in wells with less than 25 feet (7.6 m) of lift, are difficult to decontaminate, and are unsuitable for sample collection. Large suction pumps are not suitable for LFP.

7.7.7.3 SUBMERSIBLE PUMPS

A submersible pump generally provides high discharge rates for purging at depths beyond the capabilities of a suction pump. Based on its size, a submersible pump can pump water from substantial depths at very high pumping rates and can provide higher groundwater extraction rates than other methods. At high pumping rates, a submersible pump can cause agitation and aeration. This results in some submersible pumps not being suitable for the collection of groundwater samples for VOC and SVOC analysis.

Adjustable rate submersible pumps, constructed of stainless steel or Teflon™, are suitable and approved for LFP provided low flow rates are maintained.

The submersible pump, including the electrical cable and lowering cable, must be decontaminated between wells in accordance with the Work Plan or QAPP.

A submersible pump installed in bedrock or in a deep well should be attached to rigid piping (i.e., 3/4-inch (1.9 cm) steel) to allow for pulling or pushing of the pump. The pump may need to be pushed or pulled to the appropriate installation depth, past tight spots in the well, and when affixing the electrical cable and lowering the cable/safety line. Even when rigid piping is used, a safety line must be attached to the pump in case the piping becomes unthreaded or the pump connection is lost.

Submersible pumps can provide high flow rates that are useful for deep well or large diameter well purging activities. They tend to be labor intensive because of decontamination problems, power supply, and discharge piping size. Some submersible pumps are not suitable for some sample analytes. Small submersible pumps (i.e., 2-inch (5 cm) Grundfos™) have the proper construction and have adjustable flow rates, making them suitable for LFP.

7.7.7.4 AIR LIFT PUMPS

An air lift pump operates using compressed air or nitrogen. The compressed air or nitrogen comes into direct contact with the groundwater and forces groundwater from the pump chamber through a series of check balls into the discharge line. An air lift pump operates on alternate pump discharge and pump recharge cycles. The pump and recharge cycles are controlled using a control box at ground surface. Air lifting is possible from deep depths with moderate to low flow rates [2 to 3 USgpm (7.6 to 11.5 L/min)] depending on the pump installation depth, static head, discharge tubing diameter, and air supply pressure.

Since the air or nitrogen comes in direct contact with the groundwater, an air lift pump should not be used for the collection of groundwater samples for VOC and SVOC analysis.

An air lift pump is a good tool for deep well purging and development. If an air lift pump is used for purging, an alternate sampling method will be required (e.g., bailers or bladder pump) for the collection of VOC and SVOC groundwater samples.

7.7.7.5 BLADDER PUMPS

Bladder pumps, as with air lift pumps, are driven by compressed air or nitrogen but the air or nitrogen does not come in contact with the groundwater. The contact between the air or nitrogen and the groundwater is eliminated by the presence of a Teflon™, polyethylene, or natural rubber bladder. The pump operation, as with the air lift pump, is cyclic and is controlled using a control box at ground surface. The control box controls the pump filling and discharge time. Because the air or nitrogen does not come in direct contact with the groundwater, and there is limited groundwater agitation and degassing, a bladder pump is the best sampling equipment for the collection of groundwater samples for VOC and SVOC analysis.

Bladder pump operation is very quiescent, causing little formation and well disturbance. By using a bladder pump, collecting a sediment-free groundwater sample is easily achieved. An adjustable rate bladder pump should be used for LFP. Bladder pumps generally are only able to achieve a maximum pumping rate of 1.5 USgpm (5.7 L/min). It is important to note that flow rates should be reduced in deep well applications.

Well purging and sampling can be performed using a bladder pump. Once sampling is completed, the pump should be disassembled and decontaminated in accordance with the Work Plan or QAPP prior to use in other wells. The sample tubing is generally 1/4- or 3/8-inch (6 or 10 mm) diameter polyethylene or Teflon™ lined polyethylene tubing. The air line is generally 1/4-inch (6 mm) polyethylene tubing. The sample and air line tubing are typically suspended in the well for future use (dedicated). At some sites a complete sampling system (bladder pump, discharge tubing, and air line) is dedicated to each well.

Bladder pumps provide excellent sample quality and are useful in deeper sampling applications. There are no analyte restrictions. Bladder pumps are strongly recommended for LFP applications.

Bladder pumps require additional equipment including control box, compressed air or nitrogen, and tubing. The setup of a bladder pump is quite labor intensive unless a dedicated system is in place. Decontamination of a bladder pump requires pump disassembly and re-assembly. Finally, bladder pumps are not capable of high flow rates, thus purging times tend to be increased slightly.

7.7.7.6 INERTIA PUMPS

An Inertia pump or Waterra™ pump is a manually operated or mechanically driven pump which uses only a foot valve on the sample/purge tubing. "Jerking" the sample/purge tubing with the attached foot valve removes groundwater from the well. The rapid lifting and lowering action of the tubing imparts an inertia to the water column within the sample/purge tubing. This causes the water column to rise to ground surface and discharge from the end of the sample/purge tubing. The foot valve holds the water column in the tubing during the lifting process and allows groundwater to enter the sample/purge tubing during the lowering, or down stroke.

CRA owns both manual and mechanical gas-powered inertia systems. Flow rates with inertia pumps are variable and are dependant on cycle speed, tubing size, foot valve size, well depth, and depth to groundwater. The inertia pump is a useful method for purging and for collection of most groundwater sample analytes. Acceptability of VOC and SVOC sampling with inertia pumps is gaining approval in selected areas. Prior to using an inertia pump as a sampling device, check the sampling requirements in the QAPP, or obtain approval from the Project Coordinator.

Inertia pumps are useful for the extraction of dense non-aqueous phase liquids (DNAPL). The only equipment that is exposed to the gross contamination is the foot valve and a small section of the sample/purge tubing. On most projects, the foot valve and sample/purge tubing are dedicated to the well.

Inertia pumps tend to cause extensive disturbance to the water column. The vigorous lifting and lowering of the inertia pump tends to make it difficult to collect sediment-free groundwater samples. Therefore, inertia pumps are not suitable for LFP.

7.7.7.7 BAILERS

A bailer is a manual sampling device consisting generally of a hollow tube (e.g., Teflon™, PVC, or stainless steel) with a lower check ball that permits water entry and prevents water loss. The bailer is lowered slowly into the well. This allows water to enter the bailer through the bottom, and the weight of the water inside the bailer closes the check ball when the bailer is retrieved from the well. A rope or cable is affixed to the bailer to allow the lowering and retrieval of the bailer from the well. Bailing tends to be disruptive to the water column and formation. Obtaining sediment-free groundwater samples using a bailer tends to be difficult, if not impossible. VOCs and SVOCs, as well as other analytes can be collected using a bailer, but it is important that these analytes be as sediment-free as possible. The compatibility of the bailer material and groundwater analytes should be reviewed and approved prior to using a bailer for the collection of groundwater samples. Generally, Teflon™ bailers are acceptable for the collection of most analytes.

Power winches with overhead tripods are available to assist in purging and sampling deep or large volume wells.

Flow rates attained using a bailer is a function of the bailer size and retrieval frequency. Retrieval frequency is dependent on well depth, water depth, and well recharge rate. Bailing is not practical for deep wells or for the removal of large well volumes.

A bailer is a useful tool for well development as the surging action from the bailer insertion and removal from the well promotes sediment suspension and subsequent removal. However, obtaining completely sediment-free samples, or samples below 50 NTU, is difficult if not impossible using a bailer.

A bailer provides representative samples once the well has been adequately developed and purged. A bailer is not suitable for LFP. Rope used for bailing must be kept off the ground and free of other contaminating material that could be introduced to the well. Rope can either be dedicated to the well for future use or discarded.

7.7.7.8 PASSIVE DIFFUSION BAGS

When sampling with diffusion bags the well must be fully developed using an alternate method.

A diffusion bag is a polyethylene bag that contain deionized water. The bag is attached to an appropriate length of rope or cable in order to be submerged to the appropriate depth (indicated in the Work Plan, QAPP, or as instructed by the Project Coordinator). Cable or rope used to suspend diffusion bags can be dedicated to the well for future use or discarded.

Once submerged to the appropriate depth, the diffusion bag is left in the well for an extended period of time, usually 14 days, to allow the bag to equilibrate with the water in the well. The use of diffusion bags eliminates well purging prior to sampling. Placement of multiple diffusion bags in a well allows for vertical groundwater profiling.

Diffusion bags are a low cost method for the collection of groundwater samples. Advantages include:

- no purge water to dispose of;
- no equipment decontamination between wells;
- simple logistics and operation;
- reduction in personnel and exposure times;
- samples collected are representative of formation water adjacent to well;
- allow for vertical profiling of water column; and
- appropriate for long-term monitoring programs.

The disadvantage of diffusion bags is the length of equilibrium time, generally 14 days. Currently, there are membranes available for diffusion bags suitable for the collection of groundwater samples for select SVOC, and metals analyses. However, there are no membranes currently available for polychlorinated biphenyls (PCBs).

<i>Note: Handle diffusion bags only when wearing clean nitrile or surgical gloves.</i>
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7.7.8 FILTERING OF GROUNDWATER SAMPLES

Filtration is an important process to remove suspended particulate that affect sample results. Filtration of groundwater samples is generally limited to metals analysis.

Filtering can be completed in the field using in-line filters or a vacuum filter kit. Filtering of samples can also be completed by the laboratory, in which case the samples must not be preserved and must be at the laboratory in at least 24 hours of sample collection.

7.8 FIELD PROCEDURES FOR RESIDENTIAL SAMPLING

7.8.1 GENERAL

When sampling potable water supply wells it is important to ensure that the samples collected are representative of the aquifer being sampled. Poor or incorrect sampling techniques will result in erroneous sample results that can be disclosed to the public. Incorrect sample results may make any changes in the public perception hard to accomplish when correct results are reported.

7.8.2 FIELD PROCEDURES

The requirements of a residential well sampling program should be reviewed with the Project Coordinator prior to initiating sampling activities. While similar field procedures used in groundwater sampling (including documentation, sample identification, date, time, etc.) are required in residential well sampling, additional procedures are also required.

Prior to collection of groundwater samples from a residential well, the well must be purged to ensure that samples collected are representative of the formation. Purging removes standing water from the well casing, pipes, and pressure or holding tank. Purging of a residential well requires the removal of one well volume. If access to the well is not available to determine the well volume, purging for a period of 15 to 30 minutes is generally sufficient. Field measurements for pH, conductivity, and temperature are recorded during purging activities until the readings indicate that stabilization has occurred.

Sampling of residential wells is generally performed using the existing pumping system. However, CRA purging and sampling equipment can be used. It is important that only designated **clean** purging and sampling equipment be used for residential well sampling. The use of the existing pumping system is preferred, as this is more representative of the water quality provided to the residence. Using the existing pumping system also minimizes the possibility of damaging the well and existing pumping system when installing additional purging and sampling equipment.

If CRA equipment is used for residential well sampling, it must be cleaned prior to and between use with a bleach and deionized water solution wash followed by a thorough deionized water rinse.

Note: In addition to the special technical procedures noted, CRA personnel must be aware of this unique situation of conducting sampling at private residences. Special care must be taken to be polite and courteous at all times. Offer only necessary information and maintain a clean work area that is returned to pre-sampling conditions. Personnel should have proper identification available, and only remain in areas long enough to

<i>complete the required tasks.</i>

Taps selected for residential well sampling should be located as close to the well as possible. Locate the taps before any treatment systems and, if possible, the pressure tank. It is important to note, if possible, all water treatment devices in operation at the residence including:

- water softeners;
- filtration units;
- ultraviolet light;
- reverse osmosis;
- distillers; and
- chlorinators.

Leaking taps that allow water to flow from the stem of the valve handle and around the tap should not be used as sampling locations. Aerators, strainers, and hose attachments should be removed prior to sampling. Maintain a steady flow of water during sampling activities to avoid pressure fluctuations that may cause sheets of microbial growth lodged in the pipes to break loose. Open the cold water tap for a period of 15 to 30 minutes to allow for the complete purging of the pumping system. Maintain a smooth-flaring water stream at a low to moderate pressure without splashing. Do not change the flow rate. Changes in the flow could dislodge particles in the pipes or faucet.

When sampling for microbiological parameters, the end of the faucet must be flame sterilized. During residential well sample, never place caps from sample containers on the ground or in a pocket. Instead, hold the sample container in one hand and the sample container cap in the other. Be very careful not to touch the inside of the sample container cap. Wear new disposable gloves at each sampling location and following contact with a potential contaminant source. The inside of the sample bottle must not be touched with bare hands or allowed to contact the surface of the faucet.

7.8.3 FIELD NOTES FOR RESIDENTIAL SAMPLING

Full documentation of each residential well is required and includes:

1. Well depth.
2. Casing construction and diameter.
3. Well installation date if known.
4. Pumping system configuration.
5. Piping system construction (e.g., copper, lead-joint, ABS).
6. Presence of treatment devices.

Obtain the name and exact mailing address for all residence or well owners, as well as home and work telephone numbers. This information is required to inform the residence or well owner of the results of the sampling activities.

Document residential well sampling activities in a standard CRA field book. Figure 3.8 provides typical residential well sampling field note requirements. Note that additional documentation of well details, treatment devices, piping system, and special circumstances are required in the field book in addition to the sample log entry.

7.9 FIELD PROCEDURES FOR SURFACE WATER SAMPLING

7.9.1 GENERAL

Surface water sampling is performed to obtain samples for surface water bodies that are representative of existing surface water conditions.

Surface water sampling locations for surface water quality and groundwater interaction studies are selected based on the following:

1. Study objectives.
2. Location of point surface discharges.
3. Non-point source discharges and tributaries.
4. Presence of structures (e.g., bridge, dam).
5. Accessibility.

During surface water sampling it is important to obtain samples that are not impacted by the re-suspension of sediment produced because of improper or poor surface water sampling techniques.

7.9.2 SURFACE WATER SAMPLE LOCATION SELECTION

Prior to conducting surface water sampling activities, the first requirement is the consideration and development of surface water sampling locations. It is important that all surface water sampling locations be selected in accordance with the Work Plan and described to and discussed with the Project Coordinator.

Bridges and piers are good locations for surface water sampling locations since they provide easy access and permit water sampling across the entire width of the surface water body. The JSA for sampling from bridges must include a traffic management plan to assure the employee has considered using a spotter, signage, cones, and flags to warn car traffic of the work adjacent to the roadway. Wading for surface water samples increases the chances of disturbance of sediments from the floor of the surface water body.

When wading for surface water samples in lakes, ponds, streams, and slow moving rivers be aware of potential safety and health risks. A life vest and safety line must be worn at all times where footing is unstable or when sampling in fast moving or more than 3 feet (0.9 m) deep. A two-person team is required for most surface water sampling activities, a Project Manager must approve a one person sampling team. If the site conditions require the use of the life vest and safety line, the two people involved in the sampling must be competent swimmers.

Surface water samples must be collected with no suspended sediments. Surface water samples are collected commencing with the furthest downstream location to avoid sediment interference with upstream locations.

7.9.2.1 RIVERS, STREAMS, AND CREEKS

Surface water samples are generally collected in areas of surface water bodies that are representative of the surface water body conditions. Representative surface water samples will usually be collected in sections of surface water bodies that have a uniform cross section and flow rate. Mixing is influenced by turbulence and water velocity, therefore the selection of surface water sampling locations immediately downstream of a riffle area (i.e., fast flow zone) will ensure good vertical mixing. These locations are also likely areas for deposition of sediment since this occurs in areas of decreased flow velocity.

Surface water sampling locations should not be established in areas near point source discharges including tributaries, industrial effluents, and municipal effluents. Surface water sampling of these source discharge points can be performed to assess the impact of these source areas on overall surface water quality.

Sample tributaries as close to the mouth as possible. It is important to select surface water sample locations considering the impact downstream, including tributary flow and sediment.

In all instances, properly document all surface water sampling locations in a standard CRA field book. Documentation may include photographs and tie-ins to known structures.

7.9.2.2 LAKES, PONDS, AND IMPOUNDMENTS

The surface water in lakes, ponds, and impoundments has a greater tendency to be stratified than water in rivers and streams. Lack of mixing in these surface water bodies may require additional surface water sample collection. Extreme turbidity variances may occur where highly turbid surface water courses enter a lake or pond. Therefore, each layer of the stratified surface water column may need to be considered separately. Stratification is generally a result of water temperature differences, with cooler heavier water being trapped below warmer water.

Surface water sample locations for lakes, ponds, and impoundments should adequately represent the conditions of the surface water body. All intakes and outflows that may provide biased surface water

representation should be identified and documented. Surface water sample locations with adjacent structures (e.g., banks, piers) may also provide biased samples, as the potential for boundary flow and eddies exists.

The number of surface water sample locations on lakes, ponds, or impoundments will vary depending on the purpose of the investigation, as well as the size and shape of the surface water body. In ponds and small impoundments a single surface water sample should be collected at the deepest point. In naturally formed ponds, the deepest point is usually near the center of the surface water body. In impoundments the point is usually near the dam.

In lakes and larger impoundments, several sub-samples should be taken to form a single composite sample. These vertical surface water sampling locations are collected along a pre-determined grid.

In irregular shaped lakes with several bays and covers that are protected from the wind, additional surface water samples are required to properly represent surface water quality at various locations in the lake. Additional surface water samples should be taken at discharges, tributaries, and other factors or sources that are suspected of affecting the surface water quality.

In all instances, properly document all surface water sampling locations in a standard CRA field book. Documentation may include photographs and tie-ins to known structures.

7.9.3 SAMPLING EQUIPMENT AND TECHNIQUES

When collecting surface water samples, direct dipping of the sample container into the stream or water is acceptable unless the sample container contains preservatives. If preserved, a pre-cleaned unpreserved sample container should be used to collect the surface water sample. The surface water sample is then transferred to the appropriate preserved sample container. When collecting surface water samples, submerge the inverted bottle to the desired sample depth and tilt the opening of the sample container upstream to fill. During surface water sample collection, wading or movement may cause sediment deposits to be re-suspended and can result in biased samples. Wading is acceptable if the stream has a noticeable current and the samples are collected directly in the sample container when faced upstream. If the stream is too deep to wade in or if additional samples must be collected at various depths, additional sampling equipment will be required. Surface water samples should be collected about 6 inches (15 cm) below the surface, with the sample bottles being completely submerged. Taking the surface water sample at this depth eliminates the collection of floating debris in the sample container.

Surface water sample collection where the flow depth is less than 1 inch (<2.5 cm) requires the use of special equipment to eliminate sediment disturbance. Surface water sampling may be conducted with a container then transferred to the appropriate sample container, or collection may be performed using a peristaltic pump. A small excavation in the stream bed to create a sump for sample collection can also be considered but should be prepared in advance to allow all the sediment to settle prior to surface water sampling activities.

Teflon™ bailers can be used for surface water sampling if it is not necessary to collect surface water samples at specific depths. A bottom loading bailer with a check ball is sufficient. When the bailer is lowered through the water, the water is continually displaced through the bailer until the desired depth is reached. The bailer is retrieved and the check ball prohibits the release of the collected surface water sample. Bailers are not suitable in surface water bodies with strong currents, or where depth-specific sampling is required.

For discrete and specified depth surface water sampling, and the parameters to be monitored do not require a Teflon™ coated sampling device, a standard Kemmerer or Van Dorn sampler can be used. The Kemmerer sampler is a brass cylinder with rubber stoppers that leave the sampler ends open while the sampler is being lowered. The sampler is lowered in a vertical position to allow water to pass through. The Van Dorn sampler is plastic and is lowered in a horizontal position. For both samplers, a messenger is sent down a rope when the sampler has reached the required depth. The messenger causes the stopper on the sampler to close. The sampler is then retrieved and the surface water sample can be collected through a valve. DO sample bottles can be filled by allowing overflow using a rubber tube attached to the valve. During depth-specific surface water sampling, take care not to disturb bottom sediments.

Glass beakers or stainless steel cups may also be used to collect surface water samples if parameter interference does not occur. The beaker or cup must be rinsed at least three times with the surface water sample prior to sample collection.

All equipment must be thoroughly decontaminated as outlined in Section 7.6.

7.9.4 FIELD NOTES FOR SURFACE WATER SAMPLING

Use a standard CRA field book to record daily surface sampling activities, describe surface water sampling locations, sampling techniques, and, if applicable, provide a description of photographs taken. Visual observations are important and provide valuable information when interpreting surface water quality results. Observations include:

1. Weather conditions.
2. Stream flow directions.
3. Stream physical conditions (width, depth, etc.).
4. Tributaries.
5. Effluent discharges.
6. Impoundments.
7. Bridges.
8. Railway trestles.
9. Oil sheens.
10. Odors.

11. Buried debris.
12. Vegetation.
13. Algae.
14. Fish and other aquatic life.
15. Surrounding industrial areas.

The following factors should be considered for surface water sampling:

1. **Predominant Surrounding Land Use:** Observe the prevalent land use type in the vicinity and note any other land uses in the area which, although not dominant, may potentially affect surface water quality.
2. **Local Watershed Erosion:** Note the existing or potential erosion of soil in the local watershed and its movement into the stream. Erosion can be rated through visual observation of watershed stream characteristics including increases or decreases in turbidity.
3. **Local Watershed Non-Point Source Pollution:** This refers to problems or potential problems other than erosion and sedimentation. Nonpoint source pollution can be diffuse agricultural and urban runoff. Other factors may include feed lots, wetlands, septic systems, dams, impoundments, and mine seepage.
4. **Estimated Stream Width:** The estimated distance from shore at a transect representative of the stream width in the area.
5. **Estimated Stream Depth:** Riffle (rocky area), run (steady flow area), and pool (still area). Estimate the vertical distance from the water surface to the bottom of the surface water body at a representative depth at three locations.
6. **High Water Mark:** Estimate the vertical distance from the bank of the surface water body to the peak overflow level, as indicated by debris hanging in bank or flood plain vegetation, and deposition of silt. In instances where bank flow is rare, high water marks may not be evident.
7. **Velocity:** Record or measure the stream velocity in a representative run area.
8. **Dam Present:** Indicate the presence or absence of a dam upstream or downstream of the surface water sampling location. If a dam is present, include specific information detailing the alteration of the surface water flow.
9. **Channelized:** Indicate if the area surrounding the surface water sampling location is channelized.
10. **Canopy Cover:** Note the general proportion of open to shaded areas which best describes the amount of cover at the surface water sampling location.

7.10 FOLLOW-UP ACTIVITIES

The following should be performed once groundwater, residential, and surface water sampling is completed:

1. Double check the Work Plan and QAPP to ensure all samples and QA/QC samples have been collected and confirm with the Project Coordinator.
2. Decontaminate all equipment at the site then return clean to the appropriate office equipment manager.
3. Dispose of purge water and cleaning fluid as specified in the Work Plan.
4. Notify the contract laboratory when the samples should arrive. Enclose a completed chain-of-custody in each cooler.
5. Complete and file the appropriate forms and data sheets. Also file the field notes. For groundwater, residential, and surface water sampling these forms include:
 - Project Planning, Completion, and Follow-Up Checklist (Form SP-02);
 - Well Development and Stabilization Form (Form SP-06);
 - Well Purging Field Information Form (Form SP-07);
 - Sample Collection Data Sheet - Groundwater Sampling Program (Form SP-08); and
 - Monitoring Well Record for Low-Flow Purging (if performed) (Form SP-09).
6. Return site and well keys.

7.11 REFERENCES

For additional information pertaining to groundwater sampling activities the user of this manual may reference the following:

ASTM D5474	Guide for Selection of Data Elements for Groundwater Investigations
ASTM D4696	Guide for Pore-Liquid Sampling from the Vadose Zone
ASTM D5979	Guide for Conceptualization and Characterization of Groundwater Systems
ASTM D5903	Guide for Planning and Preparing for a Groundwater Sampling Event
ASTM D4448	Standard Guide for Sampling Groundwater Wells
ASTM D6001	Standard Guide for Direct-Push Water Sampling for Geoenvironmental Investigations.

For additional information pertaining to surface water sampling, the user of this manual may reference the following:

ASTM D5358	Practice for Sampling with a Dipper or Pond Sampler
ASTM D4489	Practices for Sampling of Waterborne Oils

ASTM D3325	Practice for the Preservation of Waterborne Oil Samples
ASTM D4841	Practice for Estimation of Holding Time for Water Samples Containing Organic and Inorganic Constituents
ASTM D4411	Guide for Sampling Fluvial Sediment in Motion
ASTM D4823	Guide for Core-Sampling Submerged, Unconsolidated Sediments
ASTM D3213	Practice for Handling, Storing, and Preparing Soft Undisturbed Marine Soil
ASTM D3976	Practice for Preparation of Sediment Samples for Chemical Analysis
ASTM E1391	Guide for Collection, Storage, Characterization, and Manipulation of Sediments for Toxicological Testing
ASTM D4581	Guide for Measurement of Morphologic Characteristics of Surface Water Bodies
ASTM D5906	Guide for Measuring Horizontal Positioning During Measurements of Surface Water Depths
ASTM D5073	Practice for Depth Measurement of Surface Water
ASTM D5413	Test Methods for Measurement of Water Levels in Open-Water Bodies

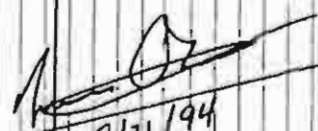
DATE/TIME	LOCATION & SAMPLE ID.	DEPTH TO W/L (FT)	WELL VOLUME (GAL)	PURGE VOLUME (GAL)	PH	COND. (S.U.)	TEMP. (°C)	CLARITY (NTU)	PURGE/SAMPLE EQUIPMENT	ANALYSIS - CONTAINER	COMMENTS
8/21/94	MW-06										
0900		9.4	11.3	12	6.2	1000	6	150 - OPAKE	Peristaltic	TAH - 1x1L	- trace petroleum
0930				24	6.8	900	5	80	Pump #2 For	ACBs - 1x1L	odor noted
1000				36	6.7	950	6	10	PURGE;	VOC'S - 3x40ml	
1030				48	6.7	930	5	10	BLADDER		
1100				60	6.8	920	7	5	PUMP #14 FOR		
1130	W-2113-821 94-MO-001	12.7		72	6.7	930	6	5 - CLEAR	SAMPLING.		
8/21/94	MILLER RESIDENCE	N.A.	N.A.								
1300	24 SUSSEX DRIVE			0	-	-	-				- AERATOR REMOVED FROM FAUCET IN KITCHEN
1310	NIAGARA FALLS			20	6.8	300	6	4 - CLEAR	- SAMPLE COLLECTED FROM KITCHEN TAP	VOC'S - 3x40ml	
1315	W-2113-821			30	6.8	300	6	5			- NO WATER CONDITIONER
1320	94-MO-002			40	6.8	310	6	5 - CLEAR			- MR. MILLER SAYS WELL IS 100' DEEP ±
 8/21/94											

figure 3.8

TYPICAL GROUNDWATER / RESIDENTIAL WATER SAMPLE LOG ENTRY



Date: _____

Reference No.: _____

PROJECT PLANNING COMPLETION AND FOLLOW-UP CHECKLIST

PRIOR PLANNING AND COORDINATION:

- ☐ Confirm well numbers, location and accessibility
- ☐ Review of project documents, Health and Safety Plan (HASP), sampling Quality Assurance/Quality Control (QA/QC) and site-specific sampling requirements
- ☐ Historical well data; depth, pH, performance and disposition of purge water
- ☐ Site access notification and coordination
- ☐ Coordination with laboratory through CRA Chemistry Group
- ☐ Procurement, inventory and inspection of all equipment and supplies
- ☐ Prior equipment preparation, calibration or maintenance
- ☐ All utilities located and approved

FIELD PROCEDURE:

- ☐ Instruments calibrated daily
- ☐ Sampling equipment decontaminated in accordance with the QAPP
- ☐ Field measurements and sampling details logged in appropriate field books or an appropriate field form
- ☐ Well volume calculated and specified volumes removed
- ☐ Specified samples, and QA/QC samples taken per Quality Assurance Project Plan (QAPP)
- ☐ Samples properly labeled, preserved and packed
- ☐ Sampling locations secured or completed according to Work Plan
- ☐ Sample date times, locations and sample numbers have all been recorded in applicable log(s)
- ☐ Samples have been properly stored if not shipped/ delivered to lab same day
- ☐ Samples were shipped with complete and accurate Chain of Custody Record

FOLLOW-UP ACTIVITIES:

- ☐ Questionable measurements field verified
- ☐ Confirm all samples collected
- ☐ All equipment has been maintained and returned
- ☐ Sampling information reduced and required sample keys and field data distributed
- ☐ Chain of Custody Records filed
- ☐ Expendable stock supplies replaced
- ☐ CRA and client-controlled items returned (i.e., keys)
- ☐ Arrange disposal of investigation generated wastes with client
- ☐ Confirm all samples collected

Completed by: _____

Date: _____

CRA

Date: _____

Reference No. _____

GROUNDWATER SAMPLING EQUIPMENT AND SUPPLY CHECKLIST

EQUIPMENT

- ☐ Required Sampling Equipment
(as per Work Plan or QAPP)

INSTRUMENTS

- ☐ Water level indicator
☐ Thermometer *
☐ pH meter *
☐ Conductivity probe *
☐ Turbidity meter
☐ HNu/OVA/Microtip
☐ Air Monitoring Equipment

SUPPLIES

- ☐ Gasoline can/gas
☐ Polypropylene rope
☐ Aluminum foil
☐ Paper towels
☐ pH buffer solution(s)
☐ Conductivity standard solution(s)
☐ Decontamination Fluids
(As per Work Plan and QAPP)
☐ Sample jars (extra)
☐ Sample jar labels (CRA) materials
☐ Cooler(s)/ice packs/packing materials
☐ Trash bags
☐ Sample preservatives
☐ Plastic spray bottles
☐ Plastic basin or pan
☐ Sample filter (On line or External Filter)
☐ Polyethylene sheeting
☐ First Aid Kit
☐ Personal Protective Equipment (as per HASP)

DOCUMENTATION

- ☐ Chain of Custody Forms
☐ Well logs
☐ Notebook/Field book
☐ Photolog
☐ Site pass/badge
☐ Federal Express manifests
☐ Previous well logs/previous historical well data
☐ Site map
☐ Blank well data forms

MISCELLANEOUS

- ☐ Well Cap Keys
☐ Bolt cutters
☐ Camera/film
☐ Knife
☐ Spare batteries for instruments
☐ Lock Deicer (winter)
☐ Reinforced packing tape
☐ Pen/pencil/indelible marking pen
☐ Tool box
☐ Spare locks/keys
☐ On Site Transportation (all Terrain Vehicle/Snowmobiles)

Completed by: _____

Date: _____

CRA

WELL DEVELOPMENT AND STABILIZATION FORM

PROJECT NAME: _____ PROJECT NO.: _____

DATE OF WELL DEVELOPMENT: _____

DEVELOPMENT CREW MEMBERS: _____

PURGING METHOD: _____

SAMPLE NO.: _____

SAMPLE TIME: _____

WELL INFORMATION

WELL NUMBER: _____

WELL TYPE (diameter/material) _____

MEASURING POINT ELEVATION: _____

STATIC WATER DEPTH: _____

ELEVATION: _____

BOTTOM DEPTH: _____

ELEVATION: _____

WATER COLUMN LENGTH: _____

SCREENED INTERVAL: _____

WELL VOLUME:

Note: For 1-inch diameter well: 1 foot = 0.04 US gallons
1 meter = 0.5 liters
For 2-inch diameter well: 1 foot = 0.16 US gallons
1 meter = 2 liters
For 4-inch diameter well: 1 foot = 0.70 US gallons
1 meter = 8.2 liters

VOLUME PURGED
(volume/total volume):

FIELD pH:

FIELD TEMPERATURE:

FIELD CONDUCTIVITY:

CLARITY/TURBIDITY VALUES:

COLOR:

ODOR:

COMMENTS:

UNITS	1	2	3	4	5	TOTAL/ AVERAGE

COPIES TO: _____

WELL PURGING FIELD INFORMATION FORM

JOB# -

SITE/PROJECT NAME:

WELL#

WELL PURGING INFORMATION

PURGE DATE
(MM DD YY)

SAMPLE DATE
(MM DD YY)

WATER VOL. IN CASING
(LITRES/GALLONS)

ACTUAL VOLUME PURGED
(LITRES/GALLONS)

PURGING AND SAMPLING EQUIPMENT

PURGING EQUIPMENT.....DEDICATED Y N

SAMPLING EQUIPMENT.....DEDICATED Y N

(CIRCLE ONE)

(CIRCLE ONE)

PURGING DEVICE ☐ A - SUBMERSIBLE PUMP D - GAS LIFT PUMP G - BAILER X-

B - PERISTALTIC PUMP E - PURGE PUMP H - WATERRA® PURGING OTHER (SPECIFY)

SAMPLING DEVICE ☐ C - BLADDER PUMP F - DIPPER BOTTLE X-

SAMPLING OTHER (SPECIFY)

PURGING MATERIAL ☐ A - TEFLON D - PVC X-

B - STAINLESS STEEL E - POLYETHYLENE PURGING OTHER (SPECIFY)

SAMPLING MATERIAL ☐ C - POLYPROPYLENE X-

SAMPLING OTHER (SPECIFY)

TUBING PURGING ☐ A - TEFLON D - POLYPROPYLENE F - SILICONE X-

B - TYGON E - POLYETHYLENE G - COMBINATION PURGING OTHER (SPECIFY)

TUBING SAMPLING ☐ C - ROPE X-

(SPECIFY)

SAMPLING OTHER (SPECIFY)

FILTERING DEVICES 0.45 ☐ A - IN-LINE DISPOSABLE B - PRESSURE C - VACUUM

FIELD MEASUREMENTS

WELL ELEVATION (m/ft)

GROUNDWATER ELEVATION (m/ft)

DEPTH TO WATER (m/ft)

WELL DEPTH (m/ft)

pH

TURBIDITY

CONDUCTIVITY

SAMPLE TEMPERATURE

 (std)

 (ntu)

 (µm/cm)

 (°C)

 (std)

 (ntu)

 (µm/cm)

 (°C)

 (std)

 (ntu)

 (µm/cm)

 (°C)

 (std)

 (ntu)

 (µm/cm)

 (°C)

 (std)

 (ntu)

 (µm/cm)

 (°C)

FIELD COMMENTS

SAMPLE APPEARANCE: ODOR: COLOR: TURBIDITY:

WEATHER CONDITIONS: WIND SPEED DIRECTION PRECIPITATION Y/N OUTLOOK

SPECIFIC COMMENTS

I CERTIFY THAT SAMPLING PROCEDURES WERE IN ACCORDANCE WITH APPLICABLE CRA PROTOCOLS

CRA

DATE

PRINT

SIGNATURE

SAMPLE COLLECTION DATA SHEET - GROUNDWATER SAMPLING PROGRAM

PROJECT NAME

PROJECT NO.

SAMPLING CREW MEMBERS

SUPERVISOR

DATE OF SAMPLE COLLECTION

[Note: For 2" dia. well, 1 ft. = 0.14 gal (imp) or 0.16 gal (us)]

Sample I.D. Number	Well Number	Measuring Point Elev. (ft. AMSL)	Bottom Depth (ft. btoc)	Water Depth (ft. btoc)	Water Elevation (ft. AMSL)	Well Volume (gallons)	Bailer Volume No. Bails	Volume Purged (gallons)	Field pH	Field Temp.	Field Cond.	Time	Sample Description & Analysis

Additional Comments:

Copies to:

CRA

MONITORING WELL RECORD FOR LOW-FLOW PURGING

Project Data:

Project Name: _____
Ref. No.: _____

Date: _____
 Personnel: _____

Monitoring Well Data:

Well No.:

Vapour PID (ppm):

Measurement Point: _____

Constructed Well Depth (m/ft): _____

Measured Well Depth (m/ft):

Depth of Sediment (m/ft): _____

Saturated Screen Length (m/ft):

Depth to Pump Intake (m/ft)⁽¹⁾: _____

Well Diameter, D (cm/in): _____

Well Screen Volume, V_s (L)⁽²⁾: _____

Initial Depth to Water (m/ft): _____

[illegible]

Notes:

- (1) The pump intake will be placed at the well screen mid-point or at a minimum of 0.6 m (2 ft) above any sediment accumulated at the well bottom.
- (2) The well screen volume will be based on a 1.52 metres (5-foot) screen length (L). For metric units, $V_s = \pi * (r^2) * L$ in mL, where $r = (D/2)$ and L are in cm. For Imperial units, $V_s = \pi * (r^2) * L * (2.54)^3$, where r and L are in inches
- (3) The drawdown from the initial water level should not exceed 0.1 m (0.3 ft). The pumping rate should not exceed 600 mL/min.
- (4) Purging will continue until stabilization is achieved or until 20 well screen volumes have been purged (unless purge water remains visually turbid and appears to be clearing, or unless stabilization parameters are varying slightly outside of the stabilization criteria and appear to be stabilizing). No. of Well Screen Volumes Purged= V_p/V_s .
- (5) For conductivity, the average value of three readings <1 mS/cm $\pm$ 0.005 mS/cm or where conductivity >1 mS/cm $\pm$ 0.01 mS/cm.

Date: _____

Reference No. _____

EQUIPMENT AND SUPPLY CHECKLIST
SURFACE WATER SAMPLING, SEDIMENT SAMPLING, AND FLOW MEASUREMENT

INSTRUMENTS:

- ☐ Measuring tape
- ☐ Steel tape (100 ft)
- ☐ Air monitoring equipment
- ☐ Velocity meter
- ☐ Flow meter
- ☐ Depth recorder/data logger
- ☐ Calculator
- ☐ Laptop computer with communication cable
- ☐ Stop watch
- ☐ Camera

EQUIPMENT:

- ☐ Sampling telescopic pole
- ☐ Sampling scoop/bucket
- ☐ Boat/motor (if required)
- ☐ Bailers
- ☐ Kemmerer/Van Dorn sampler
- ☐ Peterson/Ponar Dredge
- ☐ Core sampler/split spoon sampler
- ☐ Stainless steel mix bowl
- ☐ Hand tools
- ☐ Other _____

SUPPLIES

- ☐ Foil
- ☐ Paper towels
- ☐ Decontamination Fluids (as required by Work Plan)
- ☐ Deionized Water
- ☐ Labels
- ☐ Sample knives
- ☐ Trash bags
- ☐ Sample Glassware
- ☐ T-bars/stakes
- ☐ Duct tape
- ☐ Markers
- ☐ Film
- ☐ Paint
- ☐ Thumbtacks

DOCUMENTATION

- ☐ Topographic Maps
- ☐ Notebook/Field book
- ☐ Photolog
- ☐ Site pass/badge
- ☐ Site Map
- ☐ Work Plan

PERSONAL PROTECTIVE EQUIPMENT:

- ☐ Waders/overboots
- ☐ Tyveks (if required)
- ☐ Life vest
- ☐ Safety line
- ☐ Protective gloves
- ☐ Hardhat
- ☐ Safety glasses
- ☐ First Aid Kit
- ☐ Check Health and Safety Plan

Completed by: _____

Date: _____