

Field Sampling Plan

**Former Mohawk Finishing Products Site
Amsterdam, New York.**

April 10, 2009

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Former Mohawk Finishing
Products Site,
Amsterdam, New York



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1. Introduction

As authorized by RPM, Inc. ARCADIS has prepared this Field Sampling Plan (FSP) for the remedial program to be conducted at the Mohawk Finishing Products site in Amsterdam, New York. The Remedial Actions will be performed in accordance with the scope of work contained in the 100% Remedial Design Report (RDR) (ARCADIS 2009). The FSP in conjunction with the Quality Assurance Project Plan (QAPP) comprise the Sampling and Analysis Plan (SAP) for the Site.

The FSP provides the framework for the sampling methodology and data collection activities performed during the VER system installation, operation and maintenance. Included in the FSP are Standard Operating Protocols & Procedures (SOPs) which detail the elements of the various field tasks; drilling and installation of monitoring wells; field measurements; sample collection; and chain of custody of sample from collection through shipment to the analytical laboratory subcontractor. The FSP incorporates accepted and standard methodology for New York State and federal environmental programs. The format and contents of the FSP have been prepared in accordance with the following U.S. Environmental Protection Agency (USEPA) guidance documents:

- USEPA. October 1988. Guidance for Conducting Remedial Investigation and Feasibility Studies Under CERCLA. Interim Final. EPA/540/G-89/004.
- USEPA. December 1987. Compendium of Superfund Field Operations Methods. EPA/P-87/001.
- USEPA. May 1978, revised May 1986. NEIC Policies and Procedures. EPA-330/9-78-001-R.

The 100% RDR contains the design of the VER system, system operation and monitoring plan, and post-remedial sampling activities. The FSP serves as a supplement for provision of the detailed SOPs. Information which is incorporated in the RA Work Plan is not repeated herein. The applicable parts of the FSP will be provided to and followed by the field team.

2. Sample Locations and Frequency

The environmental media which will or may be sampled for laboratory analyses include during the course of investigative activities at the site:

- Groundwater

- Soil vapor
- Subsurface soils

The designated locations and anticipated number of these samples are specified in the RA Work Plan. Groundwater samples will be collected from the designated monitoring wells, specified in the RA Work Plan, and from sampling ports installed at designated locations within the VER treatment system. Soil vapor samples will be collected from designated sampling parts within the VER system. In addition to the soil samples collected for laboratory analyses, split-spoon samples will also be collected for geologic characterization from the monitoring well and recovery well locations. Subsurface soil samples will be collected from soil borings as part of closure activities.

3. Data Collection Protocols and Procedures

The equipment, protocols and procedures for the data collection activities are described in detail in the appended SOPs. Equipment decontamination procedures are also included in the SOPs.

The following SOPs are included as appendices to the FSP:

<u>FSP Appendix</u>	<u>Title</u>
A	Geoprobe™ Groundwater and Soil Sampling Procedures
B	Borehole Drilling, Subsurface Soil Sampling Protocol and Recovery and Monitoring Well Specifications and Installation Protocol
C	Groundwater Sampling Protocol
D	Treatment System Sampling and Monitoring
E	Water-Level Measurement
F	Field Instrumentation Operating Procedures

4. Construction-Generated Wastes

Drill cuttings, purge water, and excess excavated soils generated during the implementation of the VER system will be handled by an appropriate manner that complies with all federal, state and local regulations. At the end of the construction activities, any hazardous waste will be transported and disposed in a proper manner in compliance with all federal, state and local regulations at an approved off-site facility

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Appendix A

Geoprobe™ Groundwater and
Soil Sampling Procedures

1. Geoprobe™ Groundwater and Soil Sampling Procedures

Previous soils and groundwater investigations at the site have been conducted using the Geoprobe™ sampling method and may be used in future stages of the investigation or remediation. Geoprobe™ is a sampling method that uses a truck mounted fold away sampling unit. The sampling unit obtains soil and groundwater samples using a hydraulically powered hammer to drive stainless steel sampling devices into the subsurface. This technique is most suitable for shallow subsurface soil and groundwater sampling.

2. Subsurface Soil Sampling

All Geoprobe™ down hole equipment will be steam cleaned prior to arrival at the site and between all boring locations. All decontamination rinse water will be containerized and stored on site awaiting proper disposal.

Soil samples will be collected continuously to the total depth of the borehole at each designated Geoprobe™ location. A clean two-inch inside diameter by 48-inch long stainless steel, macro sampler will be used to collect samples continuously to 12 feet below land surface. The macro sampler is an open tube design sampler that is fitted with a removable culling shoe and acetate liner. After the soil sample is collected the shoe is removed and the sample is extruded from the acetate liner. A large bore stainless steel drive point sampler will be used for depths greater than 12 feet. The large bore sampler, approximately 1.2-inch inside diameter by 24-inch long, will be used to collect samples continuously for the remaining depth of the borehole. The closed large bore sampler will be driven to two feet above the selected interval where it is then opened and then driven to the desired sample interval. Releasing the stop pin allows a piston to retract inside the sampling tube as it is displaced by the soil core. Samplers are fitted with new acetate liners prior to each use.

Soil samples will be described noting color, grain size, moisture content and compactness using the modified Burmister classification system. Samples of ARCADIS soil/core logs can be found in Appendix I. After the samples have been described, they will be removed from the acetate liners, placed into sample containers, covered with aluminum foil and capped for volatile organic compound (VOC) head space analysis. Samples will be allowed to equilibrate for 15 minutes before head space is measured. Head space analysis will be measured using a photoionization detector (PID). After 15 minutes, the cap will be removed from the container and the foil pierced with the tip of the

PID. The PID will be calibrated daily according to procedures outlined in Appendix G. PID readings will be recorded with soil classification information on the soil core logs.

3. Groundwater Sampling

Groundwater samples will be collected from discrete intervals within the designated Geoprobe™ soil boring locations. Groundwater samples are collected using a standard Geoprobe™ screen point sampler. A clean sampler will be driven to the desired sample interval and then retracted approximately two feet. The stainless steel screen is inserted into the hollow rods and then pushed into the resulting void via chase rods from the surface. The screen remains retracted within the probe rods until the desired interval is reached. The screen is not exposed to the formation until it is pushed from its protective sheath. Once the screen is exposed, new polyethylene tubing fitted with a stainless steel check valve is inserted into the rods. The tubing is then attached to a peristaltic pump and the groundwater sample is collected. In an attempt to minimize turbidity, every effort will be made to remove a minimum of one gallon of groundwater before the analytical sample is collected. In low yielding formations (till), this amount may not be achievable. When collecting groundwater samples within the lower till formation, a “closed” type Geoprobe™ sampler will be driven through the upper fill materials and into the lower unit. The screen will not be exposed until it has penetrated the till unit, thus minimizing the risks of cross contamination from the upper unit. Groundwater samples will be collected in laboratory containers, labeled and placed in an ice filled cooler. Samples will be collected according to volatilization sensitivities. Sample shipment and chain-of-custody procedures will be followed according to procedures outlined in Appendix H.

Appendix B

Borehole Drilling, Subsurface Soil
Sampling Protocol and Recovery
and Monitoring Well Specifications
and Installation Protocol

1. Borehole Drilling

The hollow-stem auger drilling method will be utilized for the drilling of soil borings and the installation of monitoring wells unless alternate methods are necessary. A ARCADIS field inspector will be present at the operating drill rig and will be responsible for the collection and logging of soil samples, monitoring of drilling decontamination operations, recording of ground-water data, deciding on final drilling depths and screen intervals (in consultation with the project manager), preparing the boring logs and well completion diagrams, and recording the well installation procedures. Additionally, the field inspector will maintain a log recording daily events, including arrivals and departures at the site by any and all personnel and equipment, and times of work start-up and stoppage. The forms to be used by the field inspector as part of the Quality Assurance/Quality Control (QA/QC) measures of the project are included in Appendix G.

If any problems are encountered or questions arise during the field investigation that are beyond the scope of expertise/responsibility of the field inspector, she/he will temporarily halt all field activities in order to confer with the project manager. In this way, a technically sound decision will be made by several experienced individuals.

1.1 Auger Drilling Technique

Unless otherwise specified in the work plan, the soil borings and monitoring wells will be drilled using hollow-stem auger techniques. This technique involves rotating a drill bit into the subsurface on a string of auger flights. Soil cuttings are continuously lifted to land surface along the outside of the flights, while drill rods and a plug are used inside the flights to keep the soil out. The plug is removable for split-spoon sampling and well installation inside the flights.

Potable water will be used during drilling if required to keep loose sand from heaving inside the auger flights (due to differential hydrostatic pressure). Sand heaving would prevent collection of representative split-spoon samples and proper installation of well casing and screen. If water is added, the volume used will be carefully documented so that at a minimum, an equivalent volume will be removed during well development. The water used will be from a potable source and will be sampled and analyzed for the same suite of analytes included in the ground-water sampling program.

1.2 Decontamination

The drilling casings, rods, samplers, tools, water tanks, drilling rig, and any piece of equipment that can come into contact (directly or indirectly) with the formation will be steam cleaned on-site prior to set up for drilling. Steam cleaning protocols will also be followed between boreholes (at a fixed on-site location) and before leaving the site at the end of the project. The on-site steam cleaning activities will be monitored by the ARCADIS field inspector.

Equipment used to sample unconsolidated sediments (e.g. split-spoon samplers, stainless-steel spatulas) will be decontaminated prior to each sample collection. Disposable gloves will be worn while equipment is cleaned to avoid contamination and the gloves will be changed frequently. The procedure for cleaning this equipment is as follows:

1. Prepare a 2-percent solution of Micro™ and distilled water in a bucket.
2. Disassemble the split-spoon sampler and immerse the parts and spatula in the Micro™ solution.
3. Scrub equipment in the bucket with a brush to remove any adhering particles.
4. Rinse the equipment with copious amounts of distilled water.
5. Place clean equipment on a clean polyethylene sheet.
6. Reassemble the cleaned split-spoon sampler.
7. Transfer the split-spoon sampler to the driller (or helper) and make sure that this individual is wearing clean, disposable gloves.

2. Formation Sampling

2.1 Split-spoon sampling

Split-spoon soil samples of unconsolidated sediments will be collected in two foot intervals from land surface to the total depth of drilling. These samples will be collected through the auger flights. A standard split-spoon sampler, which is 24 inches long and 2

inches in diameter, will be used for sampling. Drill cuttings will be examined in two foot intervals throughout the entire depth of the hole.

The collected split-spoon soil samples will be described, cataloged and retained by the on-site field inspector. It is the responsibility of the field inspector to ensure that between sample collections, the sampling device is cleaned according to the protocol outlined previously. In this way, if contamination is encountered at one elevation in the borehole, it will not be transferred to lower elevations in the borehole. A detailed soil sampling protocol is as follows:

1. The cleaned split-spoon sampler will be given to the driller (or helper), by the ARCADIS field inspector who will make sure that the individual is wearing clean, disposable gloves.
2. The split-spoon sample will then be collected by the driller using the standard penetration test. (ASTM D1586).
3. The ARCADIS field inspector will obtain the split-spoon sampling device from the driller and will place it on clean polyethylene sheeting.
4. The end cap will be unscrewed and the spoon opened to expose the sample.
5. The sample will be screened for volatile organic compound (VOCs) as discussed below.
6. The ARCADIS Sample/Core Log will be filled out as discussed below.
7. The sampling equipment will be cleaned as previously described.

After collection, split-spoon samples of unconsolidated material will be visually identified by the field inspector using the modified Burmister classification System. The information recorded on the sample/core log by the field inspector will include:

- Soil sample interval
- Sampling hammer weight and distance of fall
- Blow count (per 6-inch interval)
- Amount of sample recovered

- Sample color
- Sample texture
- Sample moisture content
- Organic vapor readings
- Unusual characteristics
- Depth to water
- Drill rig behavior and penetration rate
- An example sample/core log is present in Appendix I. Representative soil samples from each sampled interval will be placed in clean glass jars with screw-type lids for future reference. Each sample container will be labeled with the site name and the boring and sample number.

3. Analytical Sampling

3.1 Headspace Analysis

For each split-spoon soil sample collect, head space analysis for VOCs will be determined using a PID. The sample jar will be covered with aluminum foil and allowed to equilibrate for 15 minutes; the aluminum foil will be pierced; and the headspace vapor reading taken. The information will then be recorded on the ARCADIS Sample/Core Log. Calibration procedures for the PID are presented in Appendix G.

3.2 Blanks

A field blank (equipment blank) will be collected to access the decontamination procedures used during soil sample collection. The blank will be prepared by pouring organic-free water over a decontaminated split-spoon sampler and into the sampling container(s). One field blank will be collected for each day of soil sampling and will be analyzed for the parameters identified in the work plan. Blank analyses are discussed in more detail in the QAPP.

3.3 Record Keeping

All ARCADIS personnel involved in sample collection will carefully document the handling history of all soil samples and blanks collected. Standard ARCADIS forms (see Appendix I) will be completed to document the integrity of each sample from the time the sampling team enters the site through sample collection and shipment.

3.4 Sample Labels and Chain-of-Custody Form

Sample labels are necessary for proper sample identification. The labels will be affixed to the sample containers prior to the time of sampling and will not be affixed to lids or caps. To track QA/QC handling protocols the labels will be filled out by sampling personnel, and the ARCADIS Chain-of-Custody form (see Appendix H) will be completed in the field before the sampling team leaves the site. Labels will include sample identification, project number, date and time collected, and analyses to be performed.

The sampling team will be responsible for maintaining custody of the samples until they are delivered to the carrier or the laboratory. The Chain-of-Custody form will then be signed and custody formally relinquished. The containers (bearing custody seals) will be in view at all times or will be stored in a secure place restricted to authorized personnel. Chain-of-Custody procedures are discussed in more detail in Appendix H.

4. Monitoring Well Installation and Development

4.1 Monitoring Well Installation

The installation of each monitoring well will begin immediately after borehole completion, or as directed by the Project Manager. Once monitoring well installation has begun, breaks will not be taken until the well has been completed and secured against unauthorized access. In cases of unscheduled delays, such as personal injury, equipment breakdowns, or sudden inclement weather, installation will be resumed as soon as practical.

4.2 Well Construction

Monitoring wells will be constructed of 2-inch diameter Schedule 40 PVC casing and screen. The well screens will be fabricated and have an inside diameter equal to the well casing. Fittings (couplings) will not restrict the inside well diameter as joints will be internally threaded. Glues, solvents, or chemical cleaners will not be used to join the

casing and screen lengths. All screens, casings, and fittings will be new material. The lengths of casing and screen will be measured and recorded by the field inspector prior to installation. All casing and screens will be decontaminated prior to installation.

Monitoring well depths and screen zones will be determined following a review, by all technical project personnel, of all available borehole data, including the field inspector's and driller's sample logs. Where shallow water table conditions exist, the well construction details described herein may be modified to allow the well screen to bridge the water table

Monitoring well screen depths will be calculated by the field inspector by maintaining accurate measurements of screen and casing placed in the borehole. Upon well completion, the field inspector will verify the screen length by sounding the well for total depth and comparing this value to the total measured length of the well materials that were lowered into the borehole.

4.3 Gravel Pack

A gravel pack will be installed in the borehole annulus around the screen. Clean silica sand backfill, suitable for the formation and screen slot size, will be placed around the screen; a weighted steel tape will be placed down the annulus periodically to measure the depth to the gravel pack to be sure it is not bridging and that it is at least 2 feet above the top of the screen.

A representative sample of the gravel pack material will be supplied by the driller prior to use. In this way, the gravel pack material can be described, in writing, using the following general guidelines: lithology, grain-size distribution, trade name (if any) and source (including company and location), and its suitability for use will be determined in advance of well construction.

4.4 Bentonite Seal

A bentonite seal (polymer-free, 100-percent bentonite) approximately 2 to 3 feet thick will be emplaced through a tremie pipe on the top of the gravel pack. The thickness of the seal will be verified by field measurements of the depth to the gravel pack and depth to the top of the seal.

4.5 Bentonite/Cement Grout

4.6 A slurry of bentonite (5 percent)/cement (95 percent) will be emplaced through a tremie pipe in the annulus between the borehole and/or surface casing and the well casing. The bentonite/cement grout will be placed from the top of the bentonite seal to approximately 2 feet below grade. Unless otherwise noted in design documents.

4.7 Protective Casing

A locking steel protective casing will be set over each well head and cemented in place to a minimum depth of 2 feet below land surface. Each protective pipe will be painted to increase visibility.

The top of the well casing will serve as the measuring point for the groundwater level measurements. The well location will be surveyed to the nearest 0.1 foot and the measuring point will be marked on the well casing and surveyed to the nearest 0.01 foot (relative to mean sea level) by a professional surveyor, licensed in New York State.

4.8 Monitoring Well Construction Diagram

A well construction diagram will be prepared by the on-site field inspector for each well and will show the following items:

1. The bottom of the borehole (that part of the borehole most deeply penetrated by drilling and/or sampling).
2. The screen setting depth.
3. The gravel pack interval.
4. The bentonite seal interval.
5. The grout interval.
6. The borehole and well casing diameters
7. The height of the well casing (without cap/plug) above ground surface.
8. The protective casing.

Each well construction diagram will be included as part of the QA/QC procedures. An example of a well construction diagram is provided in Appendix I.

4.9 Monitoring Well Development

A record of well development will be maintained along with the other pertinent well data as part of the QA/QC procedures. Well development will not be attempted until at least 24 hours after installation. Well development will be accomplished using an appropriate technique(s), such as pumping with a centrifugal pump, low-flow submersible pump, surging with air, mechanical surging of the well, or any combination of the above. Development will continue until the well responds to water-level changes in the formation, and the well produces clear, sediment-free water to the extent possible. Development water will be collected and disposed of properly.

Dispersing agents, acids, disinfectants, or other additives will not be used during development nor will they be introduced into the well at any other time. During development, water will be removed from the entire column of water standing in the well by periodically lowering and raising the pump intake.

Well development will include the rinsing of the interior well casing above the water column in the well using only water from that well. The well will be covered with a clean well cap which will be rinsed with distilled water prior to installation. The result of this operation will be a well casing free of extraneous materials (grout, bentonite, sand, etc.).

The following data will be recorded as part of development and QA/QC procedures:

1. The static water-level measured from the top of the well casing before and after development is completed.
2. The calculated quantity of fluid standing in the well prior to development.
3. The sounded well depth before and after development to determine if siltation has occurred inside the well.
4. The physical character (e.g., clarity, color, particulates, and odor) of water removed, including changes during development.
5. The type and size/capacity of pump used.

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6. The surging techniques used.
7. The quantity of fluid/water removed and the time of removal (both incremental and total values).

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Appendix C

Groundwater Sampling Protocol

1. Introduction

Valid water-chemistry data are integral to hydrogeologic investigations that characterize groundwater quality conditions. The data will be confirmed by quality-control measures instituted during sampling, sample handling, and analysis. Without checks on the procedures, contradictory results are possible, and incomplete or incorrect conclusions may result.

Quality control includes proper sampling procedures for well purging prior to sampling, sample-removal methods that utilize acceptable materials for all equipment and supplies, sample processing (including filtration, preservation, labeling, and bottle filling), and sample shipment. The ARCADIS project manager and field personnel will work closely with the analytical laboratory to assure that samples reach the laboratory in proper condition.

The reported data will be assessed for internal consistency, and the results will be interpreted in light of constituents expected from previous investigations and from chemical and biochemical transformations that may have occurred in the subsurface. Water-quality data will be scrutinized according to ARCADIS's Quality Assurance/Quality Control (QA/QC) protocols for data validation as discussed in the Quality Assurance Project Plan (QAPP).

ARCADIS's groundwater sampling protocol is based on standard practices as published in, "Manual of Ground-Water Sampling Procedures", by Scaif and others, NWWA/EPA, 1981 and "Handbook for Sampling and Sample Preservation of Water and Wastewater", EPA, 1982, as well as on ARCADIS's own extensive experience.

Pertinent information regarding groundwater sampling procedures will be recorded on ARCADIS's daily and sampling logs. Copies of these forms are included in Appendix I.

2. Preparation For Sampling

A written sampling fact sheet containing the information needed by the field team will be prepared by the project manager. The fact sheet will be reviewed and verified by a qualified ARCADIS chemist and will include the protocol (standard or non-standard) to be followed. Information on the types and nature of hazardous chemicals that may be encountered will be provided along with a list of special precautions for sampling, handling, storage, and transportation.

3. Preparation of Sampling Equipment

The sampling equipment will be thoroughly cleaned before each use. Any supplies, such as tubing or rope that cannot be properly cleaned after each use will be discarded in an appropriate manner. Water level measuring equipment will be cleaned with a laboratory-grade detergent solution, and rinsed with distilled water prior to use. A new length of polypropylene cord will be attached to a new dedicated bailer prior to the collection of each sample. Equipment, such as specific conductance, turbidity and pH meters, will be calibrated daily according to manufacturer's instructions.

4. Sampling Equipment

The equipment needed for sampling groundwater is listed below:

Electric water level probe (M-scope)	Thermometers
Clean rags	Sample bottles
Distilled water	Indelible marking pens
Plastic sheeting	Brushes
Polypropylene rope	Pump
Bailers, Teflon™	½ - inch Polyethylene tubing
Micro™ laboratory cleaner	Clear tape
Buckets, graduated	12 volt battery
Gloves (Latex, Nitrile, or equivalent)	Beakers
pH Meter and buffers	Ice
Specific Conductance meter	Coolers

5. Arrival At The Site

Upon arrival at the site, sampling personnel will check in with the appropriate personnel to coordinate sampling team activities and to obtain necessary clearances.

5.1 Opening the Well

Upon arrival at the well site, sampling personnel will check the well for aboveground damage, record the well designation, wipe the top of the well clean, and then remove the cap and wipe the top of the well casing with a clean cloth. Plastic sheeting will be placed around the well to protect sampling equipment from potential contamination.

5.2 Sounding the Well

The total depth of the wells will be measured (sounded) prior to sampling. With this information, the sampling team can calculate the volume to water in the well and determine if formation material has accumulated in the well. The well depth will be measured to an accuracy of 0.01 feet below the measuring point.

5.3 Measuring Well Stick-Up

The height of the measuring point above ground surface (the stick-up) will be measured to determine whether the well has been disturbed since installation. The stick-up will be measured to an accuracy of 0.01 feet.

5.4 Measuring the Water Level

Prior to purging and sampling, the static water level in the well will be measured and the volume of standing water in the well will be calculated. A full round of water levels will be taken prior to water sampling. The date and time of each measurement will be recorded. Each measurement will be made to an accuracy of 0.01 feet below the measuring point. Care will be taken to avoid cross contamination of the wells by thoroughly cleaning the measuring instrument between well sampling events.

Water levels will be measured in monitoring wells by using an electric water level probe (M-scope) and oil/water interface probe where separate-phase product is present or suspected. The measuring point, which is permanently marked on each well, will be used to assure consistent water-level readings. The procedure will be as follows:

1. The well will be identified and its number recorded.
2. The top of the well will be wiped with a clean cloth.
3. Plastic sheeting will be placed around the well.
4. The well cap or plug will be removed; the inside of the casing will be wiped with a clean cloth; and the cap will be placed down in a manner so as to keep it clean. Personnel will wait approximately 10 minutes, if necessary, prior to measuring the water level to allow the water to stabilize.
5. The air within the well will be analyzed for VOCs by using a photoionization detector.
6. The first 5 feet of the steel measuring tape or electric probe will be cleaned as described above and then the depth to water will be measured from the top of the well casing.
7. The volume of water in the well will be calculated.

5.5 Purging the Well

Standing water will be removed from the well casing prior to collecting groundwater samples; a centrifugal pump, low-flow submersible pump or disposable Teflon \square bailer will be used. The tubing from the pump will be set just below the anticipated dynamic (pumping) water level. New tubing will be dedicated to each well sampled.

The water level in the pumped well will be monitored in the event that it drops enough to make it necessary to reduce the discharge rate and/or lower the tubing. It is important that the entire water column be evacuated prior to sampling. The tubing will be set at the pumping water level and just prior to completion of the evacuation, the tubing will be lifted or the discharge increased so that suction is broken. The entire column of water will thus be removed from the well.

Three to five times the calculated volume of water in the well will be removed so that the sample subsequently collected will be representative of the zone screened. The volume of standing water in each well will be calculated by subtracting the depth to water from the sounded depth of the well. This number will then be multiplied by a coefficient which

relates the diameter of the well to gallons per linear foot to obtain the volume of standing water in the well.

5.6 Collection of Groundwater Sample

After a well has been evacuated, a groundwater sample will be collected with a disposable, bottom-filling Teflon[®] bailer. The bailer will be lowered slowly so that the water surface is minimally disturbed. Water will enter the bailer through a hole in the bottom end plug and will be prevented from draining out by an inert ball check-valve. A polypropylene rope will be used to raise and lower the bailer, and the cord will be discarded after each well sampling event. The bailer will not come in contact with any surfaces outside of the well casing. Sampling personnel will wear a new pair of disposable gloves for each well sampled and when handling a clean bailer.

5.7 Filling the Containers

The containers will be inspected to ensure that they are the correct type and number, and if required, have the correct preservative. The labels will then be properly filled out and affixed to the containers. Water samples will be carefully poured into the containers, avoiding agitation or turbulence, which might result in loss of VOCs and/or excessive oxygenation of the samples. Care will also be exercised to avoid breakage and to eliminate the entry or contact of, any substance with the interior surface of the bottles, vials, or caps, other than the water sample being collected. Caps will not be removed until the actual sampling time and then just long enough to fill the container. The containers for volatile organic analyses will be topped off to eliminate any headspace or air bubbles and will be tightly closed with Teflon[®]-lined septums held in place by open-top screw caps. The sample bottles will be prepared with appropriate preservatives prior to sampling, and the sample containers will be kept cool, dust-free, and out of the sun. The procedures that ARCADIS personnel will follow to collect groundwater samples are described below:

1. All containers will be labeled, marked according to project, well, date, etc., and wrapped with clear tape.
2. Clean gloves will be worn by personnel when they are handling a clean bailer.
3. The bailer will be placed on clean plastic sheeting. An appropriate length of new polypropylene cord will be attached to the bailer using a secure knot.

4. The bailer will be lowered into the well and into the water column gradually to minimize turbulence. The bailer will be allowed to sink and become fully submerged. Water from the first bailer will be discarded as a final rinse prior to sampling.
5. The 40 milliliter (ml) vials for VOCs will then be filled in such a manner as to ensure that there are no air bubbles.
6. After volatile organic samples have been collected, field parameters will be analyzed from the next water sample. The remaining sample containers will be filled in the order of the parameter's volatilization sensitivity.
7. The pH, specific conductance, turbidity, Eh, dissolved oxygen, and temperature measurements, if required, will be taken after the meters have been calibrated, as necessary.
8. The well cap will be closed and the well will be locked.
9. Groundwater samples will be packed on ice in a cooler. The ARCADIS Water Sampling Log form and ARCADIS Chain-of-Custody form will be completed. Samples will be delivered or shipped to the laboratory within 24 hours after sample collection and the receiver's signature will be obtained on the Chain-of-Custody form.
10. The cord, gloves, bailer and sheeting will be discarded in a proper manner.

6. Field Analysis

If required, measurements for temperature, pH, turbidity, Eh, dissolved oxygen, and specific conductance will be made in the field at the time of groundwater sampling because these properties change during storage. Field measurements will be recorded on the ARCADIS Water Sampling Log (see Appendix I) to track QA/QC protocols.

7. Quality Control

Quality-control (QC) samples will be used to monitor sampling and laboratory performance. The types of QC samples that will be included in this investigation are replicates and blanks. To ensure unbiased handling and analysis by the laboratory, the identity of QC samples will be disguised by means of coding so that the laboratory does not know which samples are included for QC purposes. Detailed QC procedures are outlined in the Quality Assurance Project Plan (QAPP).

7.1 Replicate Analyses

Replicate samples are samples collected from the same well and are identical within the limits of normal concentration fluctuations. Collection and analysis of such samples allow a check to be made on laboratory reproducibility. Five percent of all groundwater samples collected at this site will be replicated. The procedures to be used for taking replicate samples is discussed below.

When collecting samples for volatile organic compound (VOC) analysis, the water from the bailer will be distributed first to fill one VOC container and then to fill the second VOC container. Adequate water will be available to fill the bottles completely before they are capped. For other analytes, the bailer of water will be split to fill portions of each sample container until the containers are filled. Replicate analyses are discussed in more detail in the QAPP.

7.2 Blanks

Trip blanks will be incorporated into this field investigation. A trip blank is a sample composed of organic-free water (prepared by the laboratory) which is filled in the laboratory and travels unopened with the sample bottles. It is analyzed along with the field samples for the constituents of interest. Analysis of trip blanks detects whether samples have been contaminated by VOCs as a result of handling in the field, during shipment, or in the laboratory. One trip blank will accompany each day's shipment of water samples to the laboratory for VOC analysis.

8. Record Keeping

All ARCADIS personnel involved in sample collection will carefully document the handling history of all groundwater samples and blanks collected. Standard ARCADIS forms (see Appendix I) will be completed to document the integrity of each sample from the time the sampling team enters the site through sample collection and shipment.

8.1 Daily Log

Daily logs will be used by the field team for QA/QC purposes to record all sampling events and field observations. Entries in the daily logs will be dated by the person making the entry, and the logs will be kept in a secure, dry place. The following types of information will be included on the log forms:

Groundwater Sampling Protocol

1. Date and time of arrival at site.
2. Client identification number.
3. Location.
4. Weather.
5. Sampling team members.
6. Work progressn
7. QC samples.
8. Departure time.
9. Delays.
10. Unusual situations.
11. Well damage.
12. Departure from established QA/QC field procedures.
13. Instrument problems.
14. Accidents.

8.2 Well Sampling Log

The sampling team will prepare a ARCADIS Water Sampling Log for QA/QC purposes (see Appendix I) at the time of sampling to record information about each sample collected. In addition to project information and well evacuation data, the log includes the following information on sampling:

1. Date and time of sampling.
2. Well evacuation data.

3. Physical appearance of samples.
4. Field observations.
5. Results of field analyses.
6. Sampling method and material.
7. Sample parameters.
8. Sample container and preservation.
9. Sampling personnel.

8.3 Sample Labels and Chain-of-Custody Form

Sample labels are necessary for proper sample identification. The labels will be affixed to the sample containers prior to the time of sampling and will not be affixed to lids or caps. To track QA/QC handling protocols the labels will be filled out by sampling personnel, and the ARCADIS Chain-of-Custody form (see Appendix I) will be completed in the field before the sampling team leaves the site. Labels will include sample identification, project number, date and time collected, analyses to be performed, and pH adjustment information where required.

The sampling team will be responsible for maintaining custody of the samples until they are delivered to the carrier or the laboratory. The Chain-of-Custody form will then be signed and custody formally relinquished. The containers (bearing custody seals) will be in view at all times or will be stored in a secure place restricted to authorized personnel. Chain-of-Custody procedures are discussed in more detail in Appendix H.

Appendix D

Treatment System Sampling and
Monitoring

1. Treatment System Sample Collection - General

Personnel will wear neoprene, nitrile or rubber boots which have been thoroughly decontaminated. Decontamination will consist of a Micro™ solution scrub, potable water rinse and final rinse with distilled water. The location of the sampling station and the sample designations will be described on the ARCADIS Sampling Log. Other pertinent data including color, appearance, and flow conditions will be recorded.

2. Sample Collection

2.1 Sampling Procedure

The station number where the sample is to be taken and sample designation will be recorded on the Water Sampling Log. The sample port shall be flushed/purged prior to collecting a sample for laboratory analysis. If a large volume of sample for multiple parameters will be collected than the combined sample bottles should be filled with a field composited sample.

Sample shipment and documentation will be in accordance with FSP Appendix H Chain-of-Custody Procedures.

2.2 pH Field Analyses

After the laboratory containers are filled, an additional sample will be collected in a clean, unpreserved glass container and its color, odor and appearance will be noted.

pH will be measured with a glass hydrogen-ion electrode compared against a reference electrode of known potential by means of a pH meter. Calibration of the pH meter will be completed before analysis with two buffer solution standards bracketing the sample pH (nominal values of 4 and 7 or 7 and 10). Before a measurement is made, the probe will be completely rinsed with deionized or distilled water. The probe will be lowered into the sample and gently stirred and allowed to equilibrate. The pH will be recorded as soon as the reading on the meter equilibrates. Between measurements the probe will be rinsed with deionized or distilled water. The pH meter will be calibrated frequently during the sampling round to ensure accurate and precise measurements.

Appendix E

Water-Level Measurement

1. Water-Level Measurement

Depth to ground water in the monitoring wells will be measured during scheduled field activities. These data will be converted to water-level elevations using surveyed vertical measuring points on individual well casings.

2. Measuring Water Levels in Wells

An electric water level meter, graduated in tenths of a foot, will be the primary instrument of measuring the depth to ground water. Prior to insertion, the measuring tape will be rinsed with a laboratory-grade detergent solution (Micro™ or equivalent), rinsed with distilled water and dried with a clean cloth. The tape will be slowly lowered down the center of the casing. After water is encountered in the well, the tape will be held at the pre-marked surveyed measuring point at the top of the well. The tape will then be removed from the well and a record made of the measurement. The depth to water will be recorded on a ARCADIS Water-Level Record Log.

ARCADIS

Appendix F

Field Instrumentation Operating
Procedures

1. Field Instrumentation Operation Procedures

Field instruments used during the investigation will be calibrated and operated in accordance with the following standard operating procedures and with the manufacturers' instructions.

2. Air Monitoring Equipment

1. A photoionization detector (PID) with a 10.6 electronvolt (eV) lamp will be used on a semi-continuous basis during intrusive field operations (drilled, sampling, etc.).
2. Calibration of the instrument shall be performed on-site prior to use on a daily basis. The calibration gas will consist of a supply of zero air and mixture of 100 parts per million (ppm) isobutylene and air. The calibration procedure is detailed in the manufacturer's instructions.
3. A dust aerosol monitoring detector (MIE pDR-1000 Personnel Data Ram) with a range of 0.001 – 400 mg/m³ (0.1 – 10µm) particle size will be used on a semi-continuous basis during intrusive field operations (drilled, sampling, etc.).

3. Field Analysis Instruments

Field analysis of groundwater may include measurements of pH, temperature, turbidity, Eh, dissolved oxygen, and specific conductance. Field instruments for the measurement of pH and specific conductance will be calibrated with standard solutions prior to sampling.

Appendix G

Chain-of-Custody Procedures

1. Chain-of-Custody Procedures

Liquid and Vapor Phase Samples

1. The field personnel will be responsible for maintaining custody of the samples until they are delivered to the overnight common carrier or courier for shipment to the laboratory. All samples shipped to a laboratory will be accompanied by a Chain-of-Custody Record. The Chain-of-Custody Record will be completed in the field; the original form will accompany the shipment, and a copy will be retained by the field staff in the field project file.
2. A separate Chain-of-Custody Record will be filled out for the contents of each shipment container (cooler for liquid phase/original lab packaging for vapor phase samples). The form will be placed in a plastic bag and taped to the inside of the shipping container.
3. To provide a means of detecting any potential tampering during shipment, all shipment containers will be affixed with signed sample seals. Two seals will be affixed to each container on opposite ends. In addition, a 2-inch wide transparent tape will be wrapped entirely around the package container.
4. If the shipment is sent by common courier, an air bill or bill of lading will be used. Receipts from courier, air bills, and bills of lading will be retained in the field project file.