ENERGYSOLUTIONS

SUPPLEMENTAL AREA B AND C INVESTIGATION AND REMEDIATION USING 3-DME; 2015 REMEDIAL ACTION WORK PLAN

FOR THE

LEICA, INC. SITE
CHEEKTOWAGA, NEW YORK

Prepared for:

Leica

LEICA, INC.

DANAHER, C/O VIDEO JET TECH
1500 MITTEL BOULEVARD
WOOD DALE, IL 60191

PREPARED BY

ENERGY*SOLUTIONS*

984 SOUTHFORD ROAD, SUITE 8

MIDDLEBURY, CT 06762

AUGUST 2015

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1.0 INTRODUCTION

This Work Plan is prepared in response to recent site data trends as well as requests from the New York State Department of Environmental Conservation (DEC) in correspondence dated June 30, 2015 for the preparation of a plan to respond to continuing concentrations of chlorinated solvents in the groundwater at southeastern corner of the Former Leica site. The DEC's letter included requests for:

- Additional hydraulic control in the vicinity of MW-11A;
- Remediation via the use of "aggressive technologies" in on-site areas with elevated chlorinated Volatile Organic Compound (VOC) concentrations; and
- Performance of enhanced bio-remediation (EBR) in the MW-26 well area, as well as in the vicinity of other wells including MW-14, MW-22, MW-25 and the area between MW-9 and MW-26.

This Work Plan is prepared in order to respond to the data trends and associated requests from the DEC as well as perform additional activities deemed appropriate based on recent monitoring results and data trends.

Work will be performed in the vicinity of the former burial area in the southeastern corner of the site at MW-11A near Rowan Road also known as Area C, and in the vicinity of the former dry well which was located at the main facility loading dock near the MW-16 well pair also known as Area B, and finally in the southwestern corner of the site near MW-2A.

1.1 SUPPLEMENTAL AREAS B AND C REMEDIAL ACTION OBJECTIVES

There are five primary objectives to be accomplished through the implementation of these supplemental remedial actions and investigations. Correspondence from the DEC, in response to the results of the site monitoring data provided in the 2014 Annual Report, requested additional actions to reduce VOC concentrations in the groundwater in the vicinity of Preston and Rowan Roads near the southeastern corner of the site. The first objective of this plan is to respond to these requests from the DEC.

Secondly, concentrations of VOCs increased in 2014 in the groundwater within the immediate vicinity of the MW-16 wells. The objective of the supplemental soil investigations in this area will be to provide additional data regarding the most appropriate potential locations in the area for the injection of 3-DME to stimulate biological remediation of the groundwater and saturated zone soils which may be causing these increases.

The third objective of these supplemental activities is to collect additional data regarding the potential capacity of the bedrock aquifer in two site locations including: the immediate vicinity of the southern groundwater recovery well, MW-11A; and also at the southwest corner of the site near MW-2A. The DEC's response to the 2014 annual report included a request for additional hydraulic control in the MW-11A area. The well capacity data collected during the supplemental activities will be used to determine whether the existing MW-11A well can be used to provide the requested additional hydraulic control.

Recent data regarding contaminant concentrations in the wells in the southern portion of the former warehouse (INT-10 and INT-11) and also in well MW-2A located to the southwest of the warehouse, suggest that VOC concentrations in the area have risen. Based on this data, consideration has been given to the installation of a supplemental hydraulic control well in this area at the southwest corner of the site. The objective of this second pumping test will be to assess the potential success and areal influence of such a recovery well.

The fourth objective of these activities will be to provide additional reduction of the VOC concentrations in the groundwater in the vicinity of Rowan and Preston Roads, and also in the vicinity of the MW-16 well pair.

The fifth and final objective of these supplemental activities is to upgrade the current groundwater recovery system. Based on the fact that the current pneumatic system has been in operation for about 15 years, and as a result of this age is frequently in need of repair, a change to a newer more cost effective remotely operated electrical system is planned.

2.0 SITE LOCATION AND DESCRIPTION

The Leica Site is located on approximately 24 acres of land at the intersection of Eggert Road and Sugar Road in the Town of Cheektowaga, Erie County, New York, (See Figure 1). The west boundary of the Site abuts the eastern boundary of the City of Buffalo. The Site is located in a generally commercial/residential area and is bounded by open land and public housing to the west, Cemetery property to the north and east and residential property to the south. The wetland located immediately to the east of Area C is the only surface water body in the general vicinity of the Site. Storm water run-off from the building roof is collected by the municipal storm water system and conveyed to Scajaquada Creek approximately one mile south of the Site. Surface water from the southern portions of the site is transmitted overland directly to the wetland area adjacent to the southeast corner of the property. Groundwater is not used for a source of drinking water. Drinking water is supplied to the surrounding area by the Erie County Water Authority from the Niagara River.

The manufacturing facility was built on the Site in 1938 by the Spencer Lens Company for the manufacture of scientific instruments and high quality optical devices. The property has been owned and operated by various other firms manufacturing similar optical related products since that time until it was used for product warehousing by the current operator since the mid 1990s.

There are three permanent buildings on-Site, including the brick multi-story Main Building of approximately 360,000 square feet, a single story metal storage building of approximately 3,100 square feet, and a one story brick fire protection system pump house of 325 square feet. The Main Building was constructed in segments from 1938 to 1967. The remainder of the Site is either paved for parking use or landscaped. The buildings are all constructed with concrete slab on grade foundations. The main building does have a basement area immediately to the south of the main loading docks in the northeast corner of the facility.

The Site is listed on the New York Registry of Inactive Hazardous Waste Sites (#915156) as a Class 2 site. A Class 2 designation indicates the property is assumed to pose a significant threat to public health and/or the environment. Revision of the Site Classification is currently under consideration by the NYSDEC based on recent remedial actions.

3.0 RECENT SITE HISTORY REVIEW

This section summarizes the recent information collected and the events that have occurred at the site which have lead to the proposal of the activities which are included in this plan.

Operation of the Leica site groundwater recovery system, and monitoring of groundwater quality in the various site areas have continued over recent years. The supplemental investigation and remediation actions included in this plan have been proposed in response to this recent monitoring data as well as the age and operational status of the site groundwater recovery system.

3.1 VOC CONCENTRATIONS IN MW-16A AND MW-16R

Following reductions achieved through the injection of HRC in the former dry well area (MW-16A and MW-16R) beginning in April of 2009, total concentrations of TCE and its associated daughter products cis 1,2 DCE and vinyl chloride (TCE and daughters) remained below 15 ug/l in the area overburden well (MW-16R) for more than three years until they began to rise again in the spring of 2013. Total TCE and daughter concentrations rose to more than 1,500 ug/l by September of 2013 and then following an extended period of recovery system "down time", reached concentrations of 7,500 ug/l by May of 2014. Although following system startup again in October of 2014, the November 2014 results yielded a reduction to less than 1,400 ug/l, totals in June of 2015 rose again to concentrations in excess of 12,500 ug/l. Based on these fluctuations and general rising trends, additional investigation of the soils and groundwater in the area and additional remedial action for the local soils and groundwater is appropriate.

Although significant reductions were realized in the MW-16R overburden well in response to the 2008 HRC injection, concentrations in the bedrock well (MW-16A) have not demonstrated similar reductions. Following the injection, the concentrations of TCE and its daughters ranged from a low of 633 ug/l in March of 2013 to a high of 1,950 ug/l in July of 2008 shortly after the injection. Concentrations of TCE and its daughters were at a total of 1,500 ug/l in November of 2014. Based on the history of concentrations in the bedrock well in this area in response to the overburden injection in 2008, additional bedrock groundwater remediation is deemed appropriate.

3.2 VOC CONCENTRATIONS IN WELLS AT ROWAN ROAD

Elevated VOC concentrations in groundwater in the vicinity of Rowan Road are thought to be the result of the former burial area in the southeastern corner of the site. Several remedial actions were implemented in the former burial area (also known as Area C) including dual vacuum extraction and soil removal. Significant success in reducing concentrations in the area has been achieved over time. Concentrations of TCE and its daughters which were once greater than 1,300 ug/l in MW-26A are now at a total of only 300 ug/l. However, although major reductions have been realized, concentrations in groundwater to the south of the original burial area continued to exceed the site Remedial Action Objectives (RAOs) in 2014.

Although TCE is not present in any of the wells in the Rowan Road area, and many of the concentrations of its daughters are also at non-detectable concentrations, RAO exceedances were still present during 2014 in wells MW-11A, MW-14 and MW-14A, MW-22, MW-22A, MW-25A, MW-26A and MW-28. MW-14 had the highest concentrations with vinyl chloride at 360 ug/l in October. MW-22 contained vinyl chloride at a concentration of 110 ug/l in October and MW-26A contained vinyl chloride at a concentration of 190 ug/l also in October.

Based on these 2014 concentrations, the DEC requested that supplemental action be performed in the area. The DEC requested the implementation of additional hydraulic control in the area in order to reduce the migration of contaminants to the south. This plan has been prepared in part as a response to that request.

3.3 VOC CONCENTRATIONS IN WELLS INT-10 AND MW-2A

The site wide groundwater monitoring system was supplemented with the installation of additional wells within the main facility warehouse area in 2013 and 2014. Additional wells were installed at the INT-2, INT-10 and INT-11 interior locations. Following the installation of these interior wells, additional information regarding the quality of the groundwater beneath the building was available. Data regarding VOC concentrations in the groundwater in these areas confirmed that VOC concentrations are elevated in the groundwater under the building. Concentrations of TCE and its daughters exceeded 5,000 ug/l in 2014 in overburden well INT-10 and also exceeded 2,500 ug/l in overburden well INT-11 during this same time period. Concentrations in bedrock well INT 10A exceeded 2,500 ug/l and concentrations in bedrock well INT-11A exceeded 550 ug/l.

Based on this data collected from wells INT-10 and INT-11, including water quality and groundwater flow direction information, it appears that contaminated groundwater in this southern area of the building may be migrating in a southwesterly direction toward MW-2A.

Data collected in 2014 and 2015 from MW-2A also suggests that this conceptual model is correct. Although concentrations of TCE and its daughters in MW-2A dropped from a maximum of 890 ug/l in March of 2012 to a low of 27 ug/l in September of 2013, they have risen once again to an elevated concentration of 740 in June of 2015.

Based on this recent data, consideration is being given to the installation of a groundwater recovery well in the general vicinity of the MW-2A well.

3.4 GROUNDWATER RECOVERY SYSTEM UPGRADE

The original remedial action implemented in 1999 included the installation of two groundwater recovery wells designed to remove groundwater from the local site bedrock and thereby gain hydraulic control of the contaminated groundwater at the site. The groundwater recovery system which was installed in 1999 included two pneumatic pumps, one in well MW-16A and one in well MW-11A. The system has operated since its installation with periodic maintenance and repair.

In recent years it has become increasingly difficult to maintain the recovery system, primarily due to its age. Frequent breaks in the compressed air lines which occur during the winter months have generated significant periods when the system has not operated. Air leaks which occurred in the early part of 2014 caused the system to be non-operational for a significant portion of the year.

Based on the recent performance of the existing groundwater recovery system, the decision was made to replace it with a new upgraded automated system with electrical pumps. We anticipate that a new system will be more reliable, more cost effective to operate and can be remotely monitored and adjusted.

4.0 PROJECT DESIGN

As discussed previously, numerous activities are planned in 2015-2016 as an integral part of this Work Plan including:

- supplemental soil investigation in the vicinity of the former loading dock drywell (MW-16) area;
- pumping tests to determine the capacity of the bedrock aquifer in two different areas;
- supplemental EBR injection in two different site areas; and
- upgrades to the existing groundwater recovery system.

Details for these proposed activities are provided below.

4.1 SUPPLEMENTAL SOIL AND GROUNDWATER INVESTIGATION

VOC concentrations in MW-16 and MW-16A have fluctuated to a significant degree since late 2012. Additional investigation of the soils and groundwater in this area will be performed in order to assess potential reasons for these fluctuations.

4.1.1 MIP Investigation for MW-16 Area

This supplemental overburden investigation will be performed through the use of Membrane Interface Probe (MIP, Hydraulic Profiling Tool (HPT), and Electric Conductance (EC) technology. The MIP/HPT/EC equipment includes two probes which are advanced into the subsurface using a GeoProbe. The MIP, HPT and EC probes generate real time data allowing decisions concerning contaminant location and supplemental sampling to be made in the field.

The Membrane Interface Probe (MIP) is a percussion tolerant VOC sensor that can continuously log volatile organics that diffuse through a semi-permeable membrane in the tool. The MIP probe can be used in the saturated or the unsaturated zone and may be advanced to the bedrock interface. Using a carrier gas, the VOCs are brought to the surface through tubing which is connected to a laboratory grade Electron Capture Device (ECD), a photo ionization detector (PID) and a flame ionization detector (FID) for immediate analysis. The ECD is coupled with the MIP system in order to enhance the detection of halogenated hydrocarbons.

The MIP system is transported on a small vehicle such as a 4x4 Diesel Mule or a 4X4 John Deere Gator. These "data acquisition vehicles" are completely self-contained (including a full set of Direct Push 1.5" probe rods pre-strung with the data trunk-line) in order to allow the on-site Direct Push unit to quickly change from driving the MIP rods to collecting soil and groundwater samples, installing monitoring points or injecting Bio-Remediation compounds.

The MIP system will also include a direct sensing soil electrical conductivity (EC) system. This system utilizes a specially designed probe that will withstand the rigors of percussion probing while taking continuous measurements of soil conductivity as it is being driven into the ground. The sensing probe is linked to a control box where the signal is received by a field computer. The signal from the probe is matched with precise depth measurements and logged on the screen. Real time data showing changes in soil conductivity/resistivity is provided. Changes in conductivity/resistivity can be used to identify lithology, contaminant plumes, salt water intrusion, or any other subsurface condition that displays a change in conductivity/resistivity.

The HPT tool is also installed in the push rod and can create fast, continuous, real-time profiles of soil hydraulic properties in both fine and coarse-grained material. The tool uses a sensitive downhole transducer to measure the pressure response of the soil to the injection of water. Data from the HPT may be used to locate and define preferential migration pathways for contaminants and also to target zones for injection of the 3-DME.

All data collected during the MIP/HPT investigation will be stored on a secure internet Share Point Site (SPS). All stakeholders will have access and be able to view the data daily on the site. The data will be presented in graph form on the SPS. Once the field work has been completed, the data will be reviewed and presented in graph form and also in three dimensional format using either vertical or horizontal cross sections or in solid model form.

This additional data collected will be used to assess the concentrations of VOCs in the soils and groundwater in the areas surrounding and downgradient of the MW-16 well pair. This data will assist in focusing the locations for supplemental injections in the area as described in this plan.

Based on the fact that the MIP can produce real time data, the sampling locations can be adjusted during the sampling activities, and the initial boundaries of the sampling area may be extended or reduce in various directions based on this real time data. The starting boundary for the area will be based on past investigation results including the soil gas sampling results collected in June of 2005, and the soil sampling results collected in December of 2005 and June of 2006. These past investigations suggested that the highest areas of soil contamination were present in the soils beneath the basement of the facility (located immediately to the north of the MW-18 well pair), and the areas located to the south/southwest of the original drywell release location.

A review of groundwater gradients vs MW-16R data over time, also confirms that the areas requiring supplemental injection are most likely to the south and southwest of the drywell release area. Although the groundwater in the area normally flows to the south and southwest from MW-16R toward MW-18, during certain periods of time in the past the bedrock recovery system has successfully reversed the flow gradient in the overburden groundwater and moved groundwater back to the north and north east from beneath the basement and the main entryway to the MW-16 well area. This trend was particularly evident from the end of 2012 through the early part of 2014 when the gradients were reversed to a significant degree for four successive monitoring periods. These reverse gradients have been evidenced by the fact that the concentrations in MW-16R have historically been the highest when the groundwater elevations in MW-18 are higher than the elevations in MW-16R, indication the groundwater is moving to the north east back to MW-16R.

Based on this information, the MIP study will begin with a series of grid sampling points centered on the highest concentrations in the basement and the main entryway room to the north (as indicated on Figure 3). The spacing between the initial grid points will be large in order to allow more areal coverage with fewer points. Once the data has been collected from the initial grid, and reviewed, additional supplemental locations may be selected. If additional locations are selected, they will be focused in the areas shown to have the highest concentrations based on the initial grid data.

Relative soil concentrations will be assessed through the collection and analysis of vapor samples through the MIP. Based on the concentrations of VOCs in the vapors and the groundwater and also the EC and HPT data, the GeoProbe may also be used to collect soil or groundwater grab samples from the areas with the highest vapor concentrations to corroborate the mass to mass concentrations with the MIP data. Also as indicated, HPT and EC information will be used in conjunction with the MIP data in order to create a complete picture of the subsurface lithology and contaminant locations. This combined data will be used to assess contaminant transport pathways and also determine the most appropriate injection locations and depths. If soil samples are collected, they will be collected using EPA 5035 sampling methodology. Once collected, the samples will be submitted to a NELAP certified laboratory for analysis via EPA Method 8260.

4.2 PUMP TESTS FOR MW-11A AND THE AREA NEAR MW-2A

Groundwater pumping tests are proposed in the following paragraphs. During the preparation of this plan, EnergySolutions contacted the Buffalo Sewer Authority (BSA) and the Town Engineering Department in order to confirm that the discharge of additional flows generated by pump testing and/or larger flow pumps would be permitted. The BSA and the Town approved the discharge of additional flows into the local sewer system. The recovered groundwater from the site, once discharged, will initially flow through collection lines which are operated by the Town, and then will eventually flow into the local treatment works which is operated by the BSA.

Pump tests are proposed for two different areas of the site including the MW-11A well area and the MW-2A well area. Recent site data has suggested that enhanced groundwater recovery may be appropriate in these two areas. The pump tests are designed to provide the information needed to assess the influence of supplemental groundwater recovery in these areas.

4.2.1 MW-11A Pump Test

Recent correspondence from the DEC requested that additional hydraulic control be provided in the areas surround the south east corner of the property and nearby Rowan Road. Additional testing will be performed on the MW-11A well to determine if this objective can be accomplished by using this existing well. To date, the groundwater recovery system has pumped approximately 7 gallons per minute from the MW-11A well while in operation. This flow rate has generated a cone of influence surrounding the well which is limited in aerial extent, particularly in the eastern direction. We believe that it may be possible to expand the recovery zone and therefore achieve the hydraulic control objective proposed by the DEC if more groundwater is recovered from this well. In order to confirm this theory, EnergySolutions will perform a pumping test on MW-11A and assess the groundwater elevations in the surrounding wells.

The existing pneumatic pump in MW-11A is not capable of recovering more than 7 gpm, therefore another pump must be used. EnergySolutions field crews will install an electric pump in the MW-11A well. The test will begin with the implementation of a step test designed to assess the amount of water the well can produce while still maintaining sufficient water in the well for the pump to operate. Once this flow rate is determined, the pump will continue to operate at this rate for approximately 48 hours while the remainder of the test is completed. A flow meter will be installed on the discharge line. We anticipate that the variation for the pumping rate will be between 10 to 20 GPM for the testing period. The pump discharge will be transferred through a flexible field hose and discharged directly to a Buffalo Sewer Authority (BSA) sewer manhole located in the immediate vicinity of MW-11A. The current BSA permit allows an approximate discharge flow rate of 13 to 14 gallons per minute to the sewer system. EnergySolutions will secure written authorization from the BSA and the Town of Cheektowaga before discharging volumes which exceed this permitted flow amount.

During the pumping test, periodic groundwater elevation measurements will be collected from the pumping well and the observation wells surrounding the pumping well in order to assess the aerial influence (i.e., the cone of depression) generated by the test operation. We anticipate that water depth measurements will be collected from the deep and shallow wells at the following locations: MW-5, MW-6, MW-9, MW-13, MW-14, MW-22, MW-25, MW-26 and MW-28. Measurements in the pumping well and several selected nearby observation wells will be collected using a pressure transducer and a data logger which will be programmed to collect data on a logarithmic schedule. Measurements from other observation wells will be collected manually with an electronic water level indicator. Observation well measurements will be collected periodically during the test with frequencies ranging from once every two to three hours at the beginning of the test to a reduced rate of once every four to eight hours during the mid and later stages of the test.

Once collected, the data will be reviewed and summarized in a report which will provide information regarding the area of influence and whether the proposed goal of additional hydraulic control may be achieved.

4.2.2 MW-2A Pump Test

As discussed in Section 3.3, although chlorinated solvent concentrations have declined in MW-2A during 2014 from a total VOC concentration high of 890 ug/l in March of 2012, recent data collected in June of 2015 has yielded total VOC concentrations as high as 874 ug/l. In response to this recent data, consideration has been given to the installation of a recovery well in the general vicinity of MW-2A in the southwestern most corner of the site.

Before installing this recovery well, additional data will be collected to evaluate the potential success of such a recovery well. A test recovery well will be installed in the southwestern most corner of the property. Following installation of the well, groundwater will be pumped from the well for approximately 72 hours (including step tests and pumping tests) and elevations in MW-2A will be monitored periodically during the test. EnergySolutions anticipates that this pumping test will be performed in a similar manner to the MW-11A pump test. The data will provide evidence regarding the potential radius of influence that may be achieved surrounding a well installed at this location. Based on this data, a decision will be made regarding whether sufficient hydraulic control can be achieved in order to capture the groundwater flowing through the MW-2A well area.

As in the case of the MW-11A well, groundwater depth measurements in the new pumping well and selected observation wells will be collected. We anticipate readings will be collected from the new well and also from wells MW-2, MW-2A, MW-3, MW-20, MW-6, MW-6A, INT-11, INT-11A INT-10 and INT-10A. Pressure transducers and data loggers which will be programmed to collect data on a logarithmic schedule will be used to collect data from selected wells in the area. Measurements from other observation wells will be collected manually with an electronic water level indicator. Observation well measurements will be collected periodically during the test with frequencies ranging from once every two to three hours at the beginning of the test to a reduced rate of once every eight to twelve hours during the mid and later stages of the test.

Once collected, the data will be reviewed and summarized in a report which will provide information regarding the area of influence and whether the proposed goal of additional hydraulic control may be achieved.

4.3 ENHANCED EBR REMEDIAL ACTIONS

Supplemental Enhanced Biological Remediation (EBR) injections will be performed at two different areas of the site including the area surrounding the former dry well (MW-16 area) and also in the areas downgradient of the former burial area surrounding MW-11A at the southeastern corner of the site.

4.3.1 Performance of EBR injection and hydraulic control in the Rowan Road area

Correspondence from the DEC requested additional hydraulic control in the areas in the general vicinity of the southeast corner of the site. The current plan to achieve chlorinated VOC reductions in the area will incorporate an EBR approach to the shallow groundwater and supplemental hydraulic control for the bedrock groundwater.

EnergySolutions proposes to perform supplemental shallow injections this area to further stimulate the ongoing biological reductive dechlorination. The supplemental EBR to be performed in the local overburden will be utilized in conjunction with the additional hydraulic control in the bedrock, with both operations designed to produce complimentary rather than conflicting results. The supplemental hydraulic control in the bedrock will be achieved through the use of a new electric pump in the MW-11A recovery well. With additional flows recovered from the well, we anticipate that the zone of influence in the bedrock will be extended. The present groundwater recovery pump located in MW-11A recovers groundwater at a rate of approximately 6.5 to 7 gallons per minute. The capacity of the new electrical pumps will be determined during the supplemental pumping tests. We anticipate that the new electrical pump will be capable of recovering from 15 to 25 gallons per minute depending on the results of the tests.

The actual areal increase in the extent of the recovery zone will be determined during the MW-11A pumping test proposed in this plan. Additional hydraulic control will be the method proposed to reduce VOC concentrations in the bedrock groundwater in the vicinity of MW-26A depending on the results of the pump test in MW-11A. The use of EBR in the bedrock groundwater is considered counterproductive when hydraulic control is in use. Injected media would be recovered from the injected areas and pumped to the local sewer lines thereby rendering the EBR process ineffective.

EBR will be used to reduce concentrations in the shallow groundwater in the Rowan Road area. EBR is expected to successfully reduce the chlorinated VOC concentrations in the shallow groundwater in the area based on the following lines of evidence:

- Data collected from the MW-26 and MW-28 well pairs in 2014, including assessment of groundwater chemistry and bacterial populations, suggests that the environment in the area is already favorable for reductive dechlorination and the bacterial populations which perform the reduction are already in place.
- With reductive dechlorination already in progress as evidence by increasing concentrations of daughter products and the groundwater chemistry data, continued use of this remedial approach remains an effective tool for protecting health and the environment. Although the hydraulic control established in this area by the deep recovery well is expected to influence the shallow flow directions to some degree, the influence is not expected to be strong enough to remove a significant portion of the injected materials from the shallow zones.

- Injections will be focused in areas where wells have demonstrated increases in DCE and VC concentrations (MW-14, and MW-22) in recent monitoring rounds. Increases in VC concentrations demonstrate reductive dechlorination is in progress. Supplemental injections will enhance this established reductive dechlorination activity.

4.3.2 Remedial approach for the MW-16 well area

An HRC injection was completed in the area surrounding the MW-16 well pair in May of 2008. The injection was performed with the use of a GeoProbe; HRC was injected into the overburden zone using direct push methods and an injection pump. The majority of the influence from this injection was observed in the overburden aquifer with total VOC concentrations declining to non-detectable levels within a year after the injection. Although significant reductions were achieved through this remedial action in the overburden, reductions in the bedrock aquifer were more limited. The total VOC concentrations in the bedrock aquifer although consistently below pre injection levels have never been below 750 ug/l and have been as high as 2,650 ug/l since the injection was performed. In addition to these sustained elevated concentrations in the deeper aquifer, overburden groundwater concentrations also began to increase again in 2013. Based on these data trends, additional actions for the shallow and the bedrock groundwater aquifers are proposed.

As indicated above, reductive dechlorination has successfully reduced chlorinated VOC concentrations in the MW-16 area in the past. Based on this past performance and in addition to other factors as discussed below, EnergySolutions believes that reductive dechlorination is the most appropriate approach to reducing concentrations in the MW-16 area.

Injections performed in 2008 were successful at reducing the concentrations in the MW-16R well to non-detectable levels in a relatively short period of time. Concentrations remained at these levels for three and a half years; however, they began to increase again in late in 2012. We believe that this delayed rebounding data trend may be explained in part by a specific contaminant fate-transport mechanisms in operation in the area; and that based on this site specific condition, the use of EBR is expected to be more successful at reducing chlorinated VOC concentrations in the local groundwater and soils than the use of chemical oxidation.

The fate-transport mechanism that we believe is affecting contaminant rebound in the area is back diffusion (i.e., where contamination diffuses back into remediated material from less-remediated material). The area lithology is comprised of a significant clay layer which is present in the soils just above the sandy silt which sits on top of the local bedrock. Back diffusion from the upper clays into the more permeable silty sand occurs over an extended period of time after the sandy silt has been flushed and the concentrations in this material have declined.

The presence of this clay lens has generated a situation where significant time is required to complete the contaminant reduction.

Based on this transport mechanism which is active in the area, it is further evident that the areas of soil in the subsurface with elevated concentrations which are affecting the groundwater are not readily accessible to injected media or groundwater flushing. Contaminants which are sequestered in clay material present in the overburden are released only under infrequent and unique circumstances via back diffusion over time as the groundwater has risen and fallen depending on the season and the successful operation of the recovery pump. Given this theory, EnergySolutions believes that a remedial method which provides more opportunity for contact time between the injected media and the contaminated soil is most appropriate. When considering the most common media used for chemical oxidation which include permanganate, hydrogen peroxide, ozone, and persulfate, injection performed with permanganate provides the longest opportunity for contact time with contaminants. Permanganate can remain active in the environment for several months; however, based on the apparent timing of these recent chlorinated VOC increases requiring years to reappear, it is evident that more time is needed for the injected media to achieve contact with the contaminants.

While typical chemical oxidation media remains active in the environment for a relatively short period of time, media used for EBR has a much longer active life. 3-DME, in particular, is specifically designed to remain active over extended periods of time. The combination of multiple electron donors present in the product allows it to remain active for up to three years, thus providing more successful contact with the contaminants in these more inaccessible locations.

Furthermore, as indicated, reductive dechlorination has been shown to be effective in the MW-16 area, and it is evident based on 2014 and 2015 data that the process is still active. The use of chemical oxidation and the injection of high concentrations of oxygen associated the chemical oxidation remedial method will significantly impact the current environment and destroy a significant portion of the anaerobic reductive dechlorinator population present in the area. Although this approach might reduce contaminant concentrations quickly in some areas, it would inhibit active reductive dechlorination and in this way limit concentration reductions in other areas where back diffusion from the clay soil zone may be occurring.

4.3.3 Injection Materials (3-DME and BDI Plus)

Supplemental EBR will be performed with the use of 3-D Microemulsion® (3-DME) produced by Regenesis of San Clemente California. 3-DME is an injectable liquid material specifically designed for in situ remediation projects where the anaerobic biodegradation of chlorinated compounds through the enhanced reductive dechlorination (ERD) process is possible.

Due to its purposefully engineered structure, 3-DME exhibits unique subsurface distribution characteristics which allow it to propagate widely within the subsurface. As a result, 3-DME can treat wide-areas around an individual injection point thereby reducing the number of application points required. Building on the 3-DME engineered molecular structure, this product is designed to provide three unique electron donor materials in a single product. This design produces a beneficial and sequential, staged-release of its three individual electron donor components allowing it to remain active in the environment over extended periods of time. This staged-release results in an immediate, mid-range and long-term, controlled-release supply of organic acids to fuel the ERD process. The staged-release offers the ERD optimizing benefit of supplying just the right amount of electron donor needed for periods of up to 2-4 years on a single application.

3-DME has been selected for the injection based the aforementioned factors including: its reduced viscosity and enhanced distribution properties and the extended time periods it remains active in the environment. These two factors will allow greater injection distribution (particularly in the bedrock in the MW-16A area) and greater areal influence as the product continues to provide electron donors as the groundwater travels through the injection zone and to the south (downgradient).

In conjunction with the 3-DME, the injection process will also incorporate the injection of supplemental bacteria to enhance the chlorinated reduction and ensure success. BioDechlor INOCULUM Plus (BDI Plus) also produced by Regenesis will be injected along with the 3-DME.

BDI Plus is designed for use at sites where chlorinated contaminants are present and unable to be completely biodegraded via the existing microbial communities. BDI Plus is an enriched, natural microbial consortium containing species of Dehalococcoides (DHC) which are capable of completely dechlorinating contaminants during in situ anaerobic bioremediation processes. BDI Plus has been shown to stimulate the rapid dechlorination of chlorinated compounds such as tetrachloroethene (PCE), trichloroethene (TCE), dichloroethene (DCE), and vinyl chloride (VC). It also contains microbes capable of dehalogenating halomethanes (e.g. carbon tetrachloride and chloroform) and haloethanes (e.g. 1,1,1 TCA and 1,1 DCA) as well as mixtures of these halogenated contaminants.

BDI Plus, provided in a liquid form, will be directly injected into the contaminated subsurface following the 3-DME injection. Once in place, this microbial consortium accelerates the existing rate of chlorinated contaminant degradation from parent compounds to intermediates (like dichloroethene (DCE) and vinyl chloride (VC)) and completely through to harmless end products such as ethene and ethane.

The BDI Plus will be used at the Leica site in order to ensure complete dechlorination. The additional bacteria will be beneficial in gaining complete dechlorination in areas at the southeastern corner of the site where light to moderate concentrations of cis 1,2-DCE and vinyl chloride have been resistant to complete reduction.

The addition of BDI Plus is viewed as a way to enhance the natural dechlorination process and make it more “aggressive” as requested by the DEC.

4.3.4 Proposed Injection Locations

4.3.4.1 Southeastern Corner of the Site

We anticipate that supplemental injections in the southeastern corner of the site will be performed in the vicinity of the MW-14 well pair located on the St. John’s Cemetery property. Final injection locations will be dependent on securing access from the respective property owners.

The current plan includes injection of the 3-DME and the BDI Plus in four rows approximately 100 to 150 feet long and oriented in an east-west direction. The four rows would be space at an approximate north-south distance of 50 feet apart; the northernmost row would run through the MW-13 well pair, the next row to the south would run through the MW-14 well pair; the third east-west row would travers just to the north of the MW-22 well pair, and the fourth row would be located in the grass strip just to the north of Rowan Road. Shallow injections to the bedrock interface would be performed at all four rows. A map of the proposed injection locations is provided as Figure 4 in Appendix A. Based on the significant challenges associated with gaining needed dispersion in fractured bedrock, and the counteracting impact of the groundwater recovery system, bedrock injections are not planned in this area.

4.3.4.2 MW-16 Area

Supplemental EBR injection with 3-DME will also be performed in the vicinity of the MW-16 well pair. We anticipate that two bedrock injection points will be install upgradient of the MW-16 well pair. These two bedrock points will be injected with the 3-DME and the BDI Plus. Based on the fact that the MW-16A well pump will be shut down, general distribution of the EBR material injected in this area is expected to be more thorough as the material will not be drawn to the well and thereby removed from the local groundwater diminishing their effect.

Overburden injection will also be performed in the area surrounding the MW-16 well pair. Overburden locations in this area will be selected based on the results of the MIP study described above and will be focused on the areas with the highest soil contamination.

Maps showing the approximate locations of the injection points are included as Figure 3 located in Appendix A. Injection locations shown in the MW-16 area are estimated at this point in time based on past investigations. A subsequent plan will be prepared following the completion of the MIP study which will provide more detail regarding the locations of these overburden injection points.

4.3.4.3 Main Warehouse Area

Additional 3-DME injections will eventually be planned for areas beneath the main warehouse of the former facility. These injections beneath the facility floors will be designed to address elevated groundwater concentrations in the immediate vicinity of wells INT-2A, and possibly wells INT-10A and INT-11A. Based on the elevated concentrations of chlorinated solvents in the groundwater in these areas, concerns have arisen regarding the potential generation of by-products such as methane or vinyl chloride when the injection is performed. Releases of these by-products into the sub-slab vapors could eventually migrate into the building resulting in possible impacts to the Sam-Son facility workers. Therefore, before the injection is performed, it will be necessary to have a system in place that can control the migration of any such gasses which are generated by the reductive dechlorination process and prevent them from entering the building. Leica is currently planning the installation of a supplemental sub-slab depressurization system (SSDS) which would address this potential problem. The injection of 3-DME in these building interior areas will be postponed until this SSDS system is in place and the migration of the generated gasses can be controlled.

In order to provide some advanced assessment regarding the amount of methane generated as a result of biological processes at the site, a multi-gas, LEL or methane meter will be used following the injections in the MW-16A area and in the MW-11A area. Following the injections, when the wells are opened for sampling, the meter will be used to assess the presence of explosive gasses in the wells.

4.3.5 Proposed Injection Procedures

Injections in the overburden above the bedrock will be performed with the use of a GeoProbe, drive rod and an injection point. Drive rods will be pushed to the bottom of the contaminated overburden immediately above the bedrock and then the 3-DME and BDI Plus will be injected as the rods are withdrawn. The 3-DME and the BID Plus will be injected under pressure via the use of an injection pump capable of delivering the fluid at a flow rate ranging from 3 to 10 gallons per minute at a pressure of 1,000 to 1,500 psig. Injected volumes will be planned based on a gallon per vertical foot rate in the injection well. Before beginning the injections, a more detailed plan will be prepared for the operation. The detailed plan will include more definitive information regarding:

- the specific locations of the injection points;
- the frequency of the injection points; and
- injection rates and injection pressures, etc.

Injections in the bedrock in the vicinity of the MW-16 wells will be performed using new, open borehole bedrock wells. The bedrock wells will be advance to approximate depths consistent with the other bedrock wells in the injection area. The wells are expected to be located in the parking area outside the main loading dock area and will therefore be finished with flush mounted curb boxes

Bedrock injection will be accomplished through the use of pressure pumps and packers. Injection will begin at the bottom of the borehole with the area isolated through the use of packers. We anticipate that vertical sections of the wells approximately ten feet in length will be isolated. Once each vertical zone has been isolated the media will be injected into the zone. This process with continue from the bottom of the well upward until the top of the bedrock has been reached. Similar to the overburden injection, before installing the new bedrock wells and beginning the injections, a more detailed plan will be prepared for the operation.

4.4 GROUNDWATER RECOVERY SYSTEM UPGRADES

EnergySolutions has contacted the Town of Cheektowaga (the Town) and the BSA regarding the discharge of additional flows into the local sewer system. Based on preliminary conversations, both agencies have agreed to permit the discharge of additional recovered groundwater flows into the local Town sewer lines. The discharge permit with the BSA will be revised to accommodate any long term flows planned in the future as a part of the implementation of this plan.

4.4.1 Shut down MW-16A

In conjunction with the submittal of the 2014 annual report, EnergySolutions submitted a request to discontinue operation of the MW-16A pump. This request was based on data collected in 2014 which suggested that significant reductions in VOC concentrations in the local groundwater could be achieved if EBR injections were added and pumping was discontinued. We understand that the Department will permit this action provided that the requested injection at the MW-16A well area is also implemented. The MW-16A well pump operation will be discontinued when the system is upgraded to electric pumps.

4.4.2 Upgrade MW-11A to electric pump

Plans are currently near completion for the upgrade to the on-site groundwater recovery system. The current recovery system was installed in 1999. The original design included the use of pneumatic pumps powered by an on-site air compressor which operates in the northern site equipment trailer. The compressor and compressed air lines are frequently in need of repair due to their age. In order to reduce system maintenance and also reduce the frequency with which the system is non-operational, the existing pneumatic system will be replaced with a new electrical system. Any new pump will be electric and will be capable of being operated remotely. In conjunction with this system upgrade, EnergySolutions will coordinate with the Town and the

BSA. Both the Town and the BSA have indicated that they will permit an increase of the flow rate into the BSA system. The current permit allows the system pumping from two locations (MW-16A and MW-11A) to discharge approximately 14 gpm to the BSA. The new pump at the MW-11A location will be capable of pumping additional flows; the actual amount will be dependent on the pump test data. As proposed above, the Pump Test to be performed at the MW-11A well will provide information regarding whether the additional flows will generate a larger cone of influence. We anticipate that the cone of influence generated by the MW-11A well pump will provide additional hydraulic control in the Rowan Road area as desired.

4.4.3 Install New Well/Pump at MW-2A

As proposed in Section 4.2 above, pump testing will also be performed in the vicinity of the MW-2A well in order to assess the potential success of an additional recovery well in the southwest corner of the site. If the testing in this area is successful, indicating appropriate hydraulic control can be achieved, an additional pumping well will be installed in this corner of this site. The pump will also be capable of being controlled remotely.

The new pumping well at the MW-2A location, if installed, will be designed to pump water from that area back to the treatment trailers for eventual discharge into the Town/BSA system through the current location.

4.5 LONG TERM MONITORING

4.5.1 Groundwater

Monitoring of selected wells will be conducted to validate the 3-DME-based enhancement of reductive dechlorination processes. After the 3-DME and BDI Plus are delivered to the subsurface, samples will be collected on a regular basis to monitor progress of the remediation program. Energy*Solutions* anticipates collecting samples quarterly for the first six months and then semiannually thereafter. The need for additional sampling will be reassessed after three years have passed.

Samples will be collected from existing wells MW-16A, MW-16R, MW-18, MW-18A, MW-24 and MW-24A, INT-12, INT-2R and INT-2A in order to assess the injection success at the loading dock and from wells MW-11A, MW-5, MW-5A, MW-9, MW-9A, MW-14, MW-14A, MW-22, MW-22A, MW-25, MW-25A, MW-26, MW-26A, MW-28, and MW-28A in order to assess the injection success at the southeastern corner of the property.

The monitoring program will include the measurement of the following field/chemical parameters:

- VOCs by EPA method 8260;
- field parameters: dissolved oxygen, ORP, pH and temperature;
- natural attenuation/inorganic parameters including: total and dissolved ferrous iron, total and dissolved manganese, total organic carbon nitrate, sulfate, and chloride; and
- Bacterial populations will be assessed semi-annually in the spring and the fall quarters.

4.5.2 Soils

In addition to the groundwater monitoring, soil sampling will also be performed in the northern injection area near the MW-16 well pair in order to assess the success of the remedial action on the soils in the area and confirm the concentrations in this source area have been reduced to the RAOs established in the Record of Decision. This post-injection soil sampling will be performed following the injection at the end of the four year active life of the 3-DME.

GeoProbe, sampling devices will be utilized in approximately five separate locations in the general vicinity of the center of the proposed shallow 3-DME injection grid south of the MW-16 well pair. Locations will be focused on the areas thought to have the highest soil concentrations before the injection based on the results from the MIP study previously discussed in this work plan. Soil samples will be collected from these five borings at a depth immediately above the water table. Samples will be collected, handled, and submitted to the laboratory in accordance with Energy*Solutions* standard sampling protocols. Each sample will be analyzed for the presence of VOCs using EPA method 8260. These results will provide information that will be used to assess the success of the initial injection and aid in determining whether additional injections are needed.

5.0 DATA ACQUISITION

5.1 SAMPLING METHOD REQUIREMENTS

5.1.1 Soil and Groundwater Samples

Post-injection soil samples will be collected from locations as specified in paragraph 4.5.2 of this Plan. Soil samples will be collected with the use of a GeoProbe. After the surface concrete has been cored using a core drill, a bore hole will be advanced in the soil at each sampling location to a depth immediately above the water table. Once the hole is in place, the sample will be collected using acetate coring sleeves. Each soil sample will be screened using a Photoionization Detector (PID). PID readings will be recorded in the field log book. Post-injection soil samples will be submitted to the laboratory for VOC analysis using EPA method 8260.

Groundwater samples will be collected from the proposed site wells using standard bailers in accordance with semi-annual monitoring procedures currently in use. Samples will be submitted to the laboratory for VOC analysis using EPA method 8260 and the other parameters as specified in Section 4.5 Long Term Monitoring.

5.1.2 Sample Handling

Soil air and groundwater samples will be collected using disposable latex or nitrile sampling gloves and specified sampling tools. The sampling gloves will be discarded after each sample, and any equipment and tools used at multiple sampling locations will be decontaminated before and after each use to prevent cross-contamination of samples.

5.1.3 Decontamination of Sampling Equipment

Re-useable sampling equipment will be decontaminated prior to use, and following sampling of each subsequent sample using the decontamination procedures outlined in *Decontamination of Field Equipment* SOP Number 82A8499.

5.1.4 Sample Container Preservation and Storage

Soil and groundwater sample container preservation and storage shall follow the requirements outlined in the *Sample Handling SOP* Number 82A8496. Additional requirements for analytical methods, sample containers, preservation, and holding times are contained in Table 6-1. All containers used to collect samples for chemical analysis will be pre-cleaned containers supplied by the laboratory. The containers will be shipped from the laboratory in sealed containers. Prior to use, the sample bottles will be inspected by Energy*Solutions'* Field Team Leader to verify their integrity. Labeling of the sample jars and the completion of Chain-of-Custody (COC) records will also be performed in accordance with Energy*Solutions' Sample Handling SOP*.

Table 5-1

Sample Handling and Analytical Protocols

Parameter	Matrix	Analytical Method	Applicable SOP*	Containers	Preservation	Holding Time
VOCs	soil	8260 analysis	82A8496 (Sample Handling) 82A8497 (Record Keeping) 82A8498 (QC Samples) 82A8499 (Decontamination) 82A8502 (Sample Logs)	4 oz. Glass	4^0 C	14 days
VOCs	water	8260 analysis	82A8496 (Sample Handling) 82A8497 (Record Keeping) 82A8498 (QC Samples) 82A8499 (Decontamination) 82A8502 (Sample Logs)	40 mil. vials	4^0 C	14 days

* Applicable Standard Operating Procedures (SOPs) are attached to this Plan in Appendix C.

5.2 ANALYTICAL METHOD REQUIREMENTS

The analytical methods to be used for the analysis of samples are contained in *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846,* EPA publication number EPA/530-SW-846.3-1). The specific analytical methods to be performed by the laboratory are outlined on Table 5-1.

5.3 QUALITY CONTROL REQUIREMENTS

Quality control samples will be collected in accordance with the *Collection of Quality Control Samples* SOP number 82A8498. The types of quality control samples to be collected in the field are identified in Table 5-2 below.

Table 5-2

Quality Control Sample Frequency

Parameter	Matrix	Sample Type	Frequency
VOCs	Soil, Water	Duplicate	1/day/20 samples
VOCs	Soil, Water	Trip Blank	1/day/20 samples

Laboratory quality control sample data to be provided with the data package will include the following sample results:

- Laboratory Control Spike
- Method Blank
- Matrix Spike/Matrix Spike Duplicate

5.4 INSTRUMENT/EQUIPMENT TESTING, INSPECTION AND MAINTENANCE

Field instrumentation to be used at the Site (photoionization detector) will be calibrated with sufficient frequency and in such a manner that accuracy and reproducibility of results are consistent with the instrument manufacturer's specifications. Copies of the calibration and operation instructions from the manufacturer will be kept with the instrument when it is used at the Site. It is the Field Team Leader's and/or Safety Officer's responsibility to be familiar with these instructions. Calibration records will be documented in the field logs to provide a historical record of instrument performance.

Equipment to be used in the field during field sampling will be examined daily to verify that it is in good operating condition. This includes checking the manufacturers' operating manual to ensure that all maintenance requirements are being observed. Preventative maintenance will be conducted for equipment to ensure the accuracy of measurement systems.

Instrumentation and monitoring equipment will be inspected before it is taken to the job site and prior to each use. Defective equipment will be taken out of service for repair.

5.5 DATA MANAGEMENT

5.5.1 Field Data

Field data collected during this project will be managed in accordance with the following Standard Operating Procedures, which are contained in Appendix C.

- Field Record Keeping - SOP #82A8497

- Lithologically Describing and Logging Soil Samples – SOP #82A8502
- Collecting Soil and Sediment Samples – SOP #82A8504
- Reviewing Data Tables – SOP #82A8515

The field data collected will be managed using forms and bound field notebooks. Laboratory data will be transcribed onto a computer-based management system. This data will be summarized in a manner that provides efficiency in data reduction, tabulation, and evaluation. All measurements taken during this project will be identified by source, type, and sample location to avoid ambiguity. Field records will include the following minimum information:

- a chronological listing of significant site events and sampling activities;
- site name, field team members, signature, and date on each page;
- site conditions, notes or sketches of sampling locations and sample descriptions;
- sample times;
- record of all measurements (e.g. field screening parameters);
- boring logs;
- photographic log (if taken); and
- well completion reports.

5.5.2 Laboratory Data

The laboratory will be responsible for maintaining analytical logbooks and laboratory data as well as a sample inventory for submittal to Energy*Solutions* on an as-required basis. Samples will be maintained by the laboratory for a period of at least 30 days after issuance of the final report by the consultant under the conditions prescribed by the appropriate analytical methods for additional analysis, if necessary. Raw laboratory data files will be maintained by the laboratory for a period of 5 years, at which time the records will be destroyed.

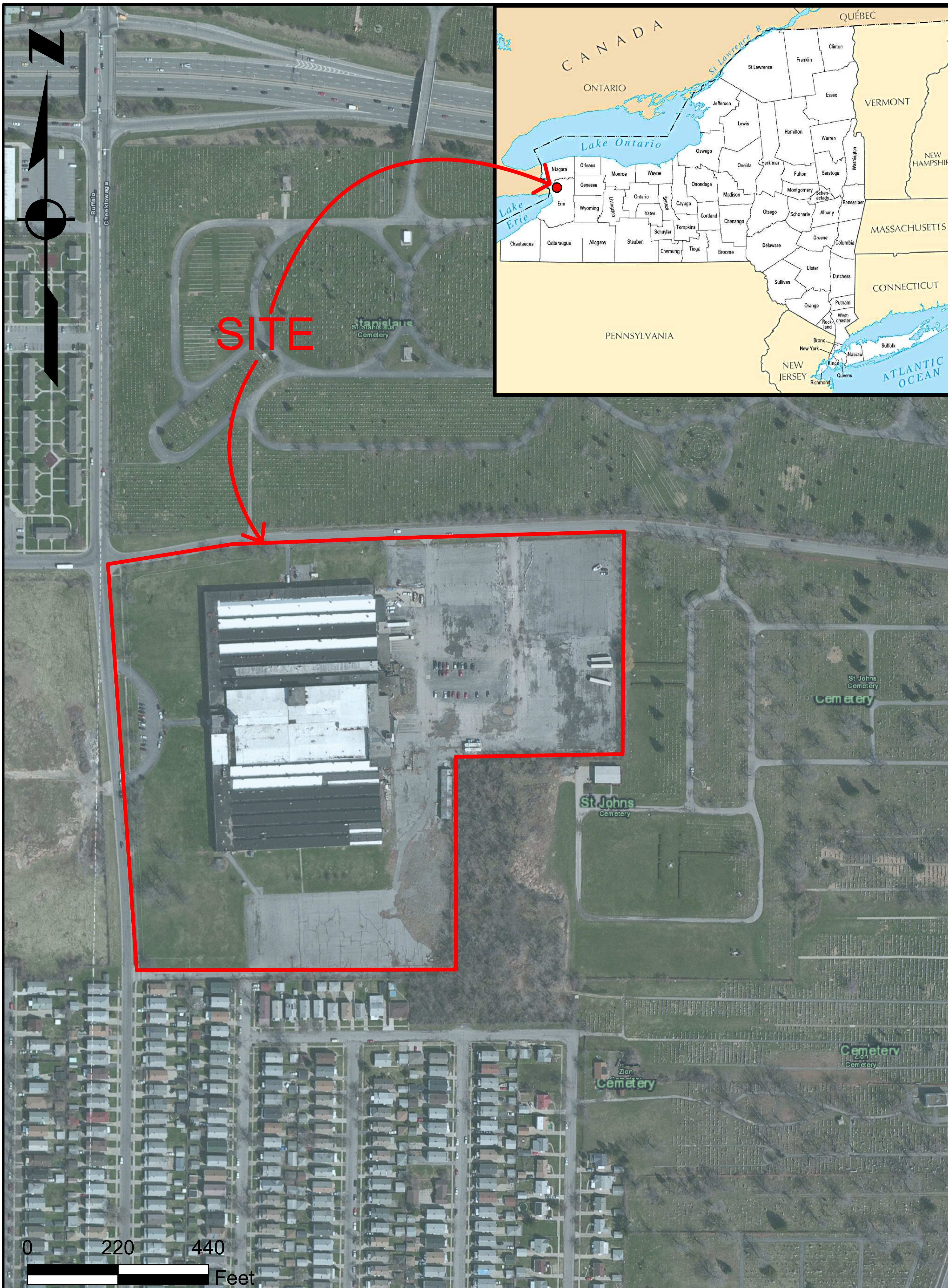
Evidentiary files for the analytical portion of the project will be maintained by the laboratory and will consist of the following records:

- Project-related plans;
- Project login data;
- Sample identification documents;
- Chain-of-Custody records;
- Project-related correspondence;
- Raw data sheets QC data;
- Copies of all final reports pertaining to the project;
- Sample preparation records.

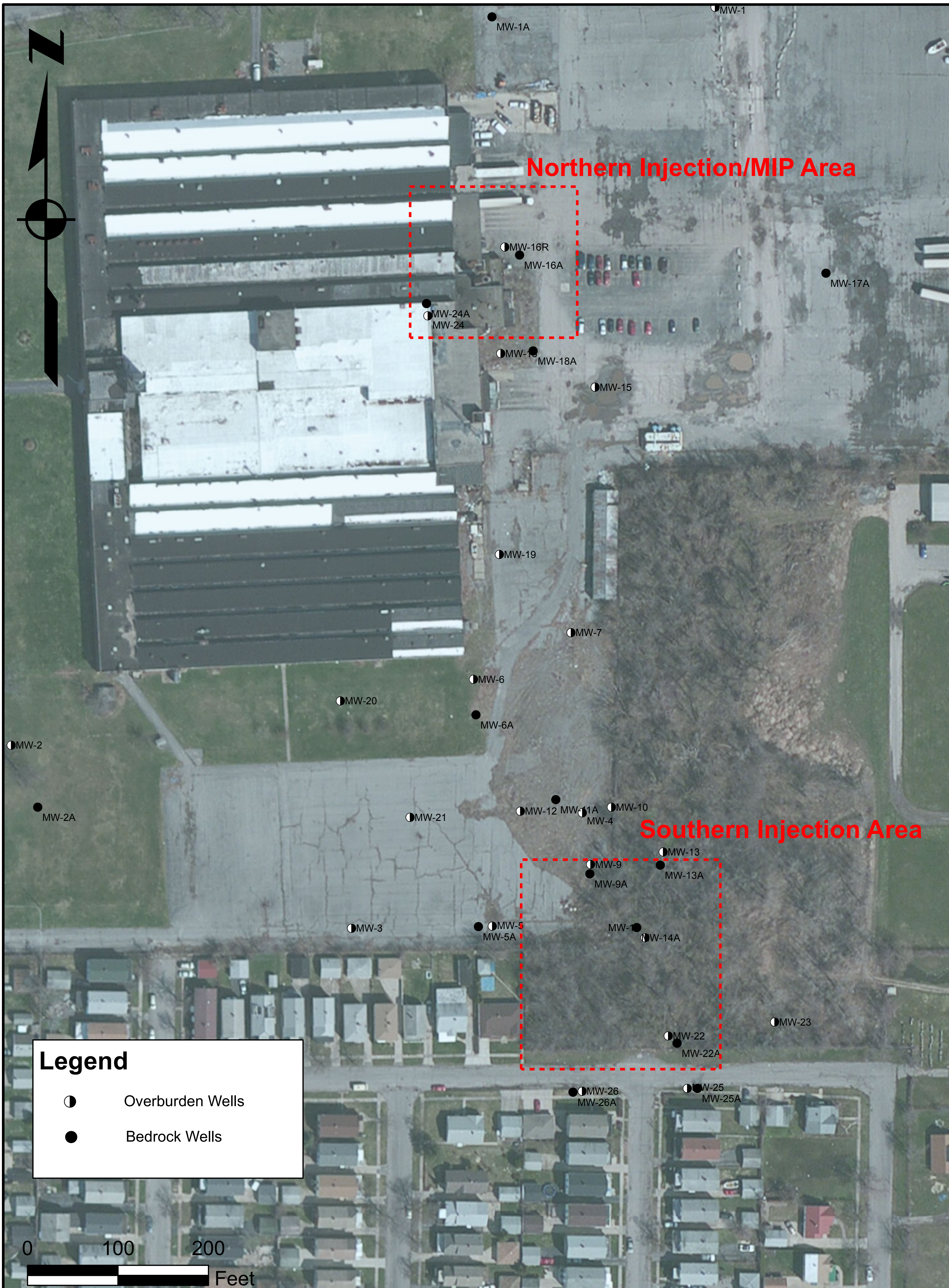
The evidentiary file materials will be the responsibility of the laboratory's representative with respect to maintenance and document removal. All laboratory deliverables are to include a complete data report including all QA/QC documentation necessary to perform full data validation.

APPENDIX A

FIGURES



DOCUMENT CONTROL NO.	PROJECT	LEICA MICROSYSTEMS INC. 203 EGGERT ROAD CHEEKTOWAGA, NY	ENERGYSOLUTIONS 984 Southford Rd Middlebury, CT 06762 203-797-8301	PROJECT # 137015	
				FILENAME:	
REVISION NO.	DRAWING	Vicinity Map		SCALE: SEE SCALEBAR	DATE: 8/13/15
				BY: MT	CK:
				FIGURE # 1	



DOCUMENT CONTROL NO.	PROJECT	LEICA MICROSYSTEMS INC. 203 EGGERT ROAD CHEEKTOWAGA, NY	ENERGYSOLUTIONS 984 Southford Rd Middlebury, CT 06762 203-797-8301	PROJECT # 137015
				FILENAME:
				SCALE: *SEE SCALEBAR* / DATE: 8/14/15
REVISION NO.	DRAWING	Site Map		BY: MT / CK:
				FIGURE # 2

DOCUMENT CONTROL NO.	PROJECT	LEICA MICROSYSTEMS INC. 203 EGGERT ROAD CHEEKTOWAGA, NY	ENERGYSOLUTIONS 984 Southford Rd Middlebury, CT 06762 203-797-8301	PROJECT # 137015
				FILENAME:
				SCALE: SEE SCALEBAR / DATE: 8/24/15
REVISION NO.	DRAWING	Proposed Northern Area MIP Locations		BY: MT / CK:
				FIGURE # 3

DOCUMENT CONTROL NO.

REVISION NO.

PROJECT

LEICA MICROSYSTEMS INC.

203 EGGERT ROAD
CHEEKTOWAGA, NY

DRAWING

Proposed Southern Area
Injection Locations

ENERGYSOLUTIONS

984 Southford Rd
Middlebury, CT 06762

203-797-8301

PROJECT # 137015

FILENAME:

SCALE: SEE SCALEBAR

DATE: 8/13/15

BY: MT

CK:

FIGURE # 4

APPENDIX B

STANDARD OPERATING PROCEDURES

"Environmental Services Standard Operating Procedure, Sample Handling"

"Environmental Services Standard Operating Procedure, Field Record Keeping"

"Environmental Services Standard Operating Procedure, Collection of Quality Control Samples"

"Environmental Services Standard Operating Procedure, Decontamination of Field Equipment"

"Environmental Services Standard Operating Procedure, Collecting Soil and Sediment Samples"

"Environmental Services Standard Operating Procedure, Low-Flow Low-Stress Groundwater Sampling"

"Environmental Services Standard Operating Procedure, Groundwater Sampling"

ENERGYSOLUTIONS

Standard Operating Procedure
Sample Handling

Authored By:	Daniel Slywka Name, Title	6/19/2012 Date
Reviewed By:	Robert McPeak Name, Title	6/19/2012 Date
Approved By	Robert McPeak Name, Title	6/19/2012 Date

- [ ] New
- [ ] Title Change
- [ ] Revision
- [X] Rewrite
- [ ] Cancellation

Effective Date 6/19/12

Table of Contents

Section **Page**

1. PURPOSE AND SCOPE

1.1 Purpose

The purpose of this Standard Operating Procedure (SOP) is to establish guidelines for sample handling that will aid in achieving consistent methods of data collection.

1.2 Scope

This SOP is designed to ensure that once samples are collected, they are preserved, packed and delivered in a manner that will maintain the utmost sample integrity. While the following procedures are appropriate for most sampling events, applicable local, state and Federal sample handling protocols and guidelines must be reviewed and considered. If necessary, modifications to the SOP can be addressed on a site-specific basis. Any modification must be clearly stated in the work plan or field sampling plan prepared for the site; these documents will always take precedence over this SOP.

2. REFERENCES

2.1 Reference 1: Standard Operating Procedure Decontamination of Field Equipment

2.2 Reference 2: Standard Operating Procedure Collection of QC Samples

3. GENERAL

3.1 Definitions

3.1.1 *Sample Container*– A glass or plastic jar or vial container used to contain and transport media from the field to the laboratory

3.1.2 *Quality Control Samples*– Samples collected for analysis which demonstrate the quality of the sample collection and handling procedures which confirm data validity.

3.1.3 *Sample Preservation*– media (such as HCL) placed in the sampling container which preserves the sample and ensures the sample analyzed by the laboratory represents the condition of the sample in the field as closely as possible.

3.1.4 *Chain of Custody*– A form which includes all pertinent information associated with the sampling effort in order to ensure the identification of individual samples and provide confirmation that custody remained in tact and that tampering or substitutions were precluded.

3.2 Responsibilities

3.2.1 The Project Manager is responsible for providing the affected employees with this SOP as necessary.

3.2.2 The Field Team Leader (FTL) is responsible for ensuring that the feld team complies with this procedure when collecting samples.

3.2.2 All Employees are responsible for adhering to this SOP when recording field activities.

3.3 Precautions and Limitations

"None"

3.4 Records

3.4.1 Field Notebooks;

3.4.2 Field standard documents

4.0 CONSIDERATIONS

2.1 Sample Containers

Prior to the sampling event, consideration must be given to the type and number of containers that will be used to store and transport the samples. The sample matrix, the analytical method, the laboratory's quality assurance/quality control (QA/QC) requirements, contaminants potentially present and local, state or Federal regulatory requirements factor into the selection of a sample container. **Typically, the contracted laboratory will select and provide the appropriate number and type of sample containers based upon the analytical methods and scope of work requested.**

Prior to sampling, make sure that the laboratory is clear on the scope of work and the objectives of the project. When performing non-routine sampling, it is also recommended that the sampling crew request instructions from the laboratory regarding the volume of sample required (e.g., matrix spike analyses for soil may require extra samples), the proper technique for filling and preserving the sample containers and the type and number of containers supplied per analytical parameter.

Sample container selection is usually based upon some combination of the following criteria:

a. Reactivity of Container Material with Sample

For sampling potentially hazardous material, glass is the recommended container type because it is chemically inert to most substances. Plastic containers are not recommended for most hazardous wastes because the potential exists for contaminants to adsorb to the surface of the plastic or for the plasticizer to leach into the sample. Species of metals will adhere to the sides of glass containers in an aqueous matrix; therefore, plastic bottles (e.g., nalgene) must be used. If metals analyses are to be performed along with other analyses, then a separate plastic bottle must be used. In the case of a strong alkali waste or hydrofluoric solution, plastic containers may be more suitable because glass containers may be etched by these compounds and create adsorptive locations on the surface of the container.

b. Volume of the Container

The volume of sample to be collected will be dictated by the analytical method and the sample matrix. Individual laboratories may provide larger volume containers or request multiple containers for a sample to ensure sufficient sample for duplicates or other QA/QC checks. Wide mouth containers are recommended to facilitate transfer of the sample from the sampler into the container without spillage or sample disturbance. Aqueous samples analyzed for volatile organic compounds (VOCs) must be placed in 40-milliliter (ml) glass vials with polytetrafluoroethylene (PTFE) (e.g., Teflon™) septum. Non-aqueous samples for VOC analysis should normally be collected in Encore Samplers or preserved 40 mil vials as specified in EPA method 5035. In some cases they may be collected in the standard non-preserved vials or in wide mouth 4-ounce (oz.) jars. These jars should have PTFE-lined screw caps. Consult the site specific sampling plan or the project manager to ensure the proper VOC sampling methods are used.

c. Color of Container

Typically, amber glass containers will be provided by the laboratory and will be used to prevent photo degradation of the sample, except when samples are being collected for metals analyses. If amber containers are not available, then containers holding the samples should be protected from light (i.e., placed in cooler with ice immediately after filling).

d. Container Closures

Container closures (i.e., caps and lids) must screw on and off the containers and form a leak-proof seal. Container caps must not be removed until the container is ready to be filled with the sample and the container cap must be replaced immediately after filling. Container caps should be constructed of a material that is inert with respect to the sampled material, such as PTFE. Alternately, the caps may be separated from the sample by a closure liner that is inert to the sample material. If soil or sediment samples are being collected, the threads of the container must be wiped clean with dedicated paper towels (or Kim wipes™) so the cap can be properly closed.

e. Decontamination of Sample Containers

Sample containers should be laboratory pre-cleaned, preferably by the laboratory performing the analysis. (The cleaning procedure will be dictated by the specific analysis to be performed on the sample.) Sample containers should be examined upon receipt to ensure that each appears clean. Do not mistake any preservative that was already deposited in the sample container by the laboratory for unwanted residue. Sample bottles received from a laboratory should not be field cleaned. If there is any question regarding the integrity of the bottle, the laboratory should be contacted and the bottle(s) replaced.

f. Sample Bottle Storage and Transportation

Extreme care should always be taken to avoid contamination of the sample bottles. Sample shuttles or coolers and sample bottles must be stored and transported in clean environments. Sample bottles and clean sample equipment should never be stored near solvents, gasoline or other equipment that is a potential source of cross contamination. When under chain of custody, sample bottles should either be custody sealed in a cooler or shuttle that is secured inside a locked vehicle or other designated secure area, or in the presence of authorized personnel.

4.2 Sample Filtering

Aqueous samples collected for dissolved metals analyses may require filtering to remove suspended sediment from the sample. Filtering must be performed prior to preserving the sample. If the sample container received from the laboratory contains preservative, then an interim container must be used to transport the sample from the collection point to the filtering apparatus. To ensure that interim containers are contaminant free, they should be supplied by the laboratory.

4.3 Decontamination of Sampling Equipment

Refer to the SOP for the Decontamination of Field Equipment for guidance on decontamination of re-usable sampling equipment.

4.4 Quality Assurance/Quality Control Samples

QA/QC samples are intended to provide control over the proper collection and subsequent review and interpretation of analytical data. Refer to the SOPs for Collection of Quality Control Samples and Field Record Keeping for detailed guidance concerning these procedures.

4.5 Sample Preservation Requirements

Certain analytical methods require that the sample be preserved in order to stabilize and maintain sample integrity. Many laboratories provide pre-preserved bottles as a matter of convenience and to help ensure that samples will be preserved immediately upon collection. Care must be exercised not to overfill sample bottles containing preservatives to prevent the sample and preservative from spilling, thereby diluting the preservative.

When samples are preserved in the field, special care must be taken. The transportation and handling of concentrated acids in the field requires additional preparation and adherence to appropriate preservation procedures. All preservation acids used in the field should be trace-metal or higher grade.

4.6 Sample Labels

Sample labels should be provided with the sample containers, but this should be verified with the laboratory. If desired, labels may be pre-printed by computer with blanks provided for variable information collected in the field. If necessary, masking tape may be used for labels in the field, but this practice should be avoided. Sample containers should always be labeled prior to opening the container to avoid cross contamination and problems associated with marking wet or dirty paper. Indelible ink markers should be used for labeling and labels should be covered with clear tape.

At a minimum, sample containers will be labeled with the following information:

site name;
project number;
initials of sampler;
sample identification code;
analytical method;
date and time of collection; and
preservative added (if applicable).

These are common sample identification codes that may be used on sample labels.

1. Sample type (medium) abbreviation may be as presented below.

ground water sample	=	GW
surface water sample	=	SW
sediment sample	=	SED
solid waste sample	=	WASTE
waste water sample	=	WW
chip sample	=	CHIP
wipe sample	=	WIPE
soil sample	=	SOIL
influent sample	=	INF
effluent sample	=	EFF
air sample	=	AIR
dust sample	=	DUST

2. Sample location abbreviation may use the identifier system established for the site. Examples of sample location abbreviations are presented below.

soil boring	=	"SB-" followed by the designated number of the boring

monitoring well	=	"MW-" followed by the designated number of the well
surface water	=	"SW-" followed by the designated number of the sampling location
surface soil	=	"SS-" followed by the designated number of the sampling location
sediment	=	"SD-" followed by the designated number of the sampling location
discharge outfall	=	"OF-" followed by the designated number of the outfall location
air	=	"AS-" followed by the designated number of the air station

3. Where applicable, depth intervals may be designated in feet or tenths of a foot (e.g., 0.5-1.0 ft).

4. Analytical parameter designations are commonly abbreviated as presented below.

volatile organic compound	=	VOC
semi volatile organic compound	=	SVOC
polychlorinated biphenyl	=	PCB
pesticide	=	PEST
metals	=	METAL
non-metallic inorganic	=	INO
geotechnical	=	GA

5. Quality control qualifiers commonly are abbreviated as presented below.

field replicate	=	R
trip or travel blank	=	TB
field or rinsate blank	=	FB
matrix spike and matrix spike duplicate	=	MS/MSD

For example, the designation "SOIL/SB-10/12-14/VOC" would indicate that the sample was a soil sample collected at Soil Boring SB-10, that it was collected at a depth interval of 12 to 14 feet below land surface, and it was selected to be analyzed for volatile organic compounds. A sample designated "GW/MW-10/R/SVOC" would indicate a replicate sample of ground water collected from Monitoring Well MW-10 and selected to be analyzed for semi volatile organic compounds.

Occasionally, the contracted laboratory supplies preprinted or bar-coded labels on the sample containers. These labels are acceptable; however, care must be exercised to ensure that coded-alike containers are not confused with other similar containers. The sampler should initial and record the time and date on each container in a blank portion of the label or on a separately attached label.

4.7 Sample Packing

Before packing containers in the cooler, all sample labels should be checked for accuracy and the caps checked for tightness. Any irregularities concerning the condition of the samples or containers should be noted on the chain-of-custody form. The bottles must be carefully packed to prevent breakage during transport. If there are any samples known or suspected to be highly contaminated, they should be packaged individually to prevent cross-contamination. Sufficient ice packs should be placed in the cooler to maintain the temperature at 4 degrees Celsius (^{O}C) until delivery to the laboratory. Consult the work plan to determine if a particular cooling agent is specified for preservation (e.g., the United States Environmental Protection Agency does not condone the use of blue packs because they claim that the samples will not hold at $4^{o}C$.) The chain of custody form should be properly completed, placed in a "zip-loc" bag and placed in the cooler. One copy must be maintained for the project file. The cooler should be sealed with strapping tape and a cooler-custody seal. The cooler drains should be taped shut to prevent leakage. The custody seal number should be noted in the field book or on the chain of custody form.

4.8 Chain-of-Custody Forms

Most contracted laboratories have their own Chain-of-Custody (COC) forms. If appropriate, use of the laboratory supplied COC forms are preferred because it reduces the chance of miscommunication between the samplers and the receiving laboratory. Otherwise, the field Team Leader (FTL) is responsible for obtaining appropriate blank COC forms from the PM for use during the sampling event.

2.8.1 Prior to initiation of field activities, the FTL is responsible for ensuring that an ample supply of COC forms are onsite to cover all of the scheduled sampling, including extra blank forms for contingency purposes.

2.8.2 The FTL reviews and familiarizes himself with the COC form and contacts the issuing laboratory for clarification of any questions concerning proper completion of the COC form.

2.8.3 Pre-completion of the COC form and sample bottle labels is limited to site generic information, e.g., site name and address, and project number.

2.8.4 The format of various COC forms will differ; however, the following information must be included on all COC forms accompanying samples collected by

Energy*Solutions*: Energy*Solutions* project number; project name; name address and telephone number and contact person; unique sample identification numbers; sample matrix; date and time samples were collected; volume, type, and quantity of sample containers; preservatives; and analyses requested. Reference methods must be specified when appropriate, e.g., *VOCs+15 (via 624)*. Special instructions and considerations should be noted in the comment section, e.g., *sample bottle not full, run TPH first*.

2.8.5 The FTL or his/her designee completes the COC form as soon as practicable after collection of the samples. Note: sample bottle labels must be completed at the time of sample collection and prior to collection of the next sample.

2.8.6 If sample custody is directly relinquished, e.g., laboratory pickup at the project site, the FTL or his/her designee: 1) signs, dates, and notes the time of the transfer; 2) gives the COC to the receiver to sign, date, and note the time; 3) takes the COC back from the receiver and reviews for completeness rectifying any deficiencies; and 4) gives the completed COC back to the receiver, retaining the appropriate carbon copy for the project files. If the COC form does not have carbon copies, a photocopy or handwritten duplicate with appropriate signatures must be made (**no exceptions**).

2.8.7 If sample custody is indirectly relinquished, e.g., express mailed to the receiving laboratory, the FTL or his/her designee: 1) signs, dates, and notes the time of the transfer; 2) places the completed COC form into the sample shuttle retaining the appropriate carbon copy; 3) completes the express mail slip and retains the appropriate carbon copy; and 4) attaches the retained copies of the COC form and express mail slip together for the project file. If the COC form does not have carbon copies, a photocopy or handwritten duplicate with appropriate signatures must be made (**no exceptions**).

4.9 Sample Delivery

Samples should be delivered to the laboratory within 24 hours of collection. If samples are shipped prior to or on a weekend or holiday, the laboratory should be contacted to confirm that someone will be available to accept delivery. Check the work plan to determine whether a shorter delivery time is imperative.

5.0 EQUIPMENT AND MATERIALS

5.1 General Equipment

a. Sample bottles of proper size and type
b. Cooler with ice (wet or blue pack)
c. Field notebook, appropriate field form(s), chain of custody form(s), custody seals
d. Black pen and indelible marker
e. Packing tape and "zip-loc" bags
f. Overnight shipping forms and laboratory address
g. Health and Safety plan (HASP)
h. Work plan/scope of work
i. Pertinent SOPs for specified tasks and their respective equipment and materials
j. Container labels

5.2 Preservatives

Preservatives for specific samples/analytes, as specified by the laboratory. Preservatives must be stored in secure spill-proof glass containers with their content, concentration, and date of preparation and expiration clearly labeled.

5.3 Miscellaneous Equipment (if appropriate)

a. graduated pipettes
b. pipette bulbs
c. Litmus paper
d. glass stirring rods
e. filtering equipment

5.4 Personal Protective Equipment (if needed)

a. protective goggles
b. disposable gloves
c. protective clothing (e.g., Tyvek™)
d. portable water supply for immediate flushing of spillage, if appropriate.
e. shovel and container for immediate containerization of spillage-impacted soil, if appropriate.

6.0 PROCEDURE

6.1 Pre-Packaging

1. Examine all bottles and verify that they are clean and of the proper type, number and volume capacity for the sampling to be conducted.

2. Label bottles carefully and clearly with the appropriate information as described in Section 2.6.

3. Collect samples in the proper manner (refer to the specific sampling SOP which addresses the sampling technique being performed).

4. Chemically preserve samples as required. Field preservation must be done immediately and should not be performed later than 30 minutes after sample collection.

5. Seal containers carefully.

6. Conduct QC sampling as required.

6.2 Packing the Shipping Container

1. Each sample container should be placed in the shipping cooler as soon as possible following the collection of the sample. Samples should not be allowed to warm up prior to packing them into the laboratory cooler for shipping.

2. Arrange containers in front of assigned coolers. Organize and carefully pack all samples in cooler immediately after collection. Pack samples so that breakage will not occur. There must be a cushion of padding (e.g., bubble wrap, vermiculite or ice in zip lock bags) between each sample container and between the containers and the top, bottom and sides of the cooler. Smaller containers, such as 40-ml vials, can be placed in "zip-lock" bags to protect them and keep them dry.

3. Complete, insert into a zip lock bag and place the chain-of-custody form in the cooler after all samples have been collected. Maintain one copy for the project file. If the cooler is to be transferred several times prior to shipment to the laboratory, it may be easier to tape the chain of custody form to the exterior of the sealed cooler. When exceptionally hazardous samples are known or suspected to be present, this should be identified on the chain-of-custody record as a courtesy to the laboratory personnel. Any other irregularities should also be noted.

4. Add additional ice as necessary to ensure that it will last until receipt by the laboratory. Ice cubes should be double packed in "zip-lock" bags to prevent leakage.

5. Seal the cooler with packing or strapping tape (make several complete revolutions) and a custody seal covered with clear tape (if available). Record the number of the custody seal in the field notebook and on the field form. If samples are shipped in the mail they should be properly labeled and comply with shipping regulations. Maintain the shipping bill along

with the chain-of-custody form for the project files and call the laboratory the next day to confirm receipt.

6. Unless specified otherwise in the superseding site-specific work plan or field sampling plan, this SOP shall govern the manner in which sample handling is performed by Energy*Solutions'* personnel. However, if field conditions or other factors dictate the need, reasonable deviation from the SOP is acceptable. Any departure from the SOP must be documented in the site-specific field notebook or project file, along with an explanation as to why the deviation was necessary.

ENERGYSOLUTIONS

Standard Operating Procedure
Field Record Keeping

Authored By:	Daniel Slywka	6/19/2012
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Approved By	Robert McPeak	6/19/2012
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1. PURPOSE AND SCOPE

1.1 Purpose

This standard operating procedure (SOP) establishes the procedures to be used for documenting and recording field activities. These activities include but are not limited to: site walk-throughs; geophysical testing; monitoring well installation; aquifer testing; air, water, groundwater, soil, and waste sampling; remediation waste removal; and installation, operation, and maintenance of remediation systems.

Field data is only as good as its documentation. Because memories fail and project personnel may change with time and task, thorough documentation is needed to accurately and permanently record observations made and information collected in the field. Standardization of field documentation helps to ensure that all pertinent information is recorded in a readily recoverable and understandable format.

Field documentation becomes part of the legal record of site activities and as such the utmost care and consideration must be given to its generation and maintenance.

1.2 Scope

The scope of this SOP is to generate quality field records that are easily interpreted, readily available, and show the progression of field activities on a chronological basis.

2. REFERENCES

2.1 Reference 1: Sample Handling

2.2 Reference 2: Standard Operating Procedure Decontamination of Field Equipment

2.1 Reference 3: Standard Operating Procedure Groundwater Sampling

2.2 Reference 4: Standard Operating Procedure Measuring Water Levels

2.3 Reference 5: Standard Operating Procedure Low-Flow/Low Stress Groundwater Purging/Sampling

2.4 Reference 6: Standard Operating Procedure, Collecting Soil and Sediment Samples

3. GENERAL

3.1 Definitions

3.1.1 *Filed Notebook* – A bound book used to maintain records of field activities

3.2 Responsibilities

3.2.1 The Supervisor is responsible for providing the affected employees with this SOP as necessary.

3.2.2 All Employees are responsible for adhering to this SOP when recording field activities.

3.3 Precautions and Limitations

"None"

3.4 Records

3.4.1 Field Notebooks;

3.4.2 Field standard documents

4. REQUIREMENTS AND GUIDANCE

4.1 General

Field notebooks must be bound and should have numbered, water resistant pages. All pertinent information regarding the site and sampling procedures must be documented. Notations should be made in logbook fashion, noting the time and date of all entries.

4.2 Materials

The following materials are needed for proper documentation of field activities:

- a bound, waterproof field notebook;
- black pens, indelible markers, and grease or wax pencils;
- all weather clip board and form holder;
- appropriate project and task specific forms (e.g., sample data sheets and boring logs); and,
- camera and film (optional).

4.3 General Procedures

4.3.1 The project manager (PM) identifies and procures all forms required for proper recording of field activities. Project specific needs, i.e., client and regulatory documentation requirements, must be considered. The required forms should be referenced and included in formal work plans, proposals or other documents.

4.3.2 The PM briefs the designated field team leader (FTL) on project documentation requirements for the task(s) at hand, gives the FTL the field notebook and provides one clean copy of each required form, if they are not already provided in the work plan.

4.3.3 The FTL is responsible for maintaining the field notebook during field activities and for bringing an adequate number of specified forms to the field site.

4.3.4 The FTL retains or assigns documentation responsibilities to field team members (FTMs) as appropriate. The number of individuals recording field activities should be minimized.

4.3.5 Whenever an alteration to a field book or data form entry is required, the incorrect entry is to be struck out with only a single line followed by the initials of the recorder making the change (e.g., ~~79 ug/l~~ JD). The revised information should be recorded next to the original entry.

4.3.6 The FTL is responsible for collecting and reviewing all field documentation at the end of each day. If possible, deficiencies in the record should be corrected immediately and the cause of the deficiency addressed.

4.3.7 The FTL is responsible for photocopying field documentation daily. Copies should be maintained physically separate from the originals. If photocopying facilities are not available at the site, field office or hotel, the FTL should copy all field documentation immediately upon returning to the office.

4.3.8 Upon return to the office, the FTL relinquishes the photocopies of the field notebook and all other field documentation to the PM.

4.3.9 The PM maintains field documentation for the project. The field notebook and all other original documents are placed in a folder labeled "Field Notes - Originals" and copies are placed in a separate folder labeled "Field Notes - Working Copies." Field notes should be filed chronologically and, where appropriate, the file folder label should include the dates when the field work was performed. Original documents are kept and eventually archived with the site files. Working copies of field notes should be used for reference during data reduction and report writing.

4.4 Procedure for Maintaining the Field Notebook

4.4.1 The PM issues a field notebook for the project which includes the following information prominently displayed on the cover or first page: the project name; number; location; and the message:

If found, please return to:
Energy*Solutions*
100 Mill Plain Road, Second Floor
Danbury, CT 06811
Attention: <project manager> or
call <project manager's phone number>
REWARD OFFERED.

4.4.2 In addition, each page of the field notebook should be sequentially numbered. Under no circumstances should pages ever be removed from the field notebook.

4.4.3 The field notebook is brought to the site during every planned and scheduled site visit. If the notebook is not brought to the site, notes should be kept on another medium using the same format as the official field notebook; these notes must be transcribed into the official field notebook as soon as practicable, along with a notation of when the transcription was made.

4.4.4 The field notebook is maintained and recorded in by one person (usually the FTL) for any given task or block of time. A change in custody is to be documented in the notebook and initialed by each individual.

4.4.5 A fresh page is used to begin each day's entries, with the day and date prominently recorded at the top followed by the weather conditions, e.g., *Friday April 23, 1993 - overcast, expected high 50º F, chance of showers*.

The next entry should include time of arrival at site, personnel present (Energy*Solutions*, Client, Regulatory, and subcontractors), and general purpose of site visit. This should be followed by a brief description of site conditions noting changes from the last time Energy*Solutions* was onsite.

4.4.6 Subsequent entries should be made in chronological order with times noted. The field notebook is a log of actions, occurrences, and activities at the site and as such should be written in the first person active voice and provide a description of who, what, where, why, when, and how. General types of information recorded in the field notebook include but are not limited to:

- arrival and departures of both Energy*Solutions* and non-Energy*Solutions* personnel and equipment;
- descriptions of both formal and informal meetings including identification of person or organization calling the meeting, purpose, location, time, attendees, topics discussed, and decisions made;
- all conversations with the client, the general public, and regulatory personnel;
- significant site- or work-related discussions between personnel and subcontractors, e.g., when decisions are made or orders given;
- telephone conversations with Energy*Solutions*, client, regulatory, and subcontracted personnel;
- health and safety procedures including level of protection, monitoring of vital signs, frequency of air monitoring, and any change (i.e., downgrade or upgrade) in the level of protection for both Energy*Solutions* and non- Energy*Solutions*
- personnel;
- deviations from the health and safety plan;
- significant changes in weather from first arrival at the site, e.g., high winds, heavy precipitation, or temperature extremes;
- air monitoring results, e.g., photo-ionization detector readings;
- site reconnaissance information such as topography, geologic features, water bodies, cultural features, and areas of suspected contamination;
- task designation and work progress;
- observations of potential contamination, e.g., stressed vegetation, stained soil, sheen on surface or ground water, etc. (descriptions should be objective and use of pejorative and/or non-technical terms, e.g., smelly and slimy, avoided);
- liberal use of sketches, drawings, and maps including measured or approximate dimensions or distances to clarify, amplify and enhance verbal descriptions;

- sample description including unique identification number, location, matrix, sample device, odor, color, texture, response to field instruments, and sample containers filled (some information may be redundant when field sample data sheets or other forms are used; nonetheless, this information should be faithfully recorded in the field notebook);
- description of photographs taken;
- deviations from the work plan;
- delays, unusual situations, problems and accidents or injuries;
- equipment and instrument problems;
- decontamination and calibration procedures;
- peripheral activities which may impact field activities; and
- time of departure of Energy*Solutions* personnel and a description of site conditions at the time of departure, e.g., non- Energy*Solutions* personnel remaining on site, vehicles, equipment, wastes, and other materials left on site, site security, etc.

4.4.7 If simultaneous activities are occurring, the FTL must make provisions for recording of activities by personnel at the work face and subsequent transcription into the field notebook. When multiple tasks are performed at remote site locations for extended periods of time, the use of additional field notebooks may be allowed with PM approval.

4.4.8 The last daily entry should be followed by the FTL's signature.

4.5 Procedure for Other Field Documentation Forms and Documents

4.5.1 Other task or project specific forms and documents may be required or appropriate for documentation of field activities, e.g., boring logs, monitoring well construction logs, air monitoring logs, sample data sheets, and chain-of-custody. Refer to the SOP Sample Handling (Energy*Solutions* Document No. 82A8496) for information regarding the proper procedure for filling out chain-of-custody forms. The FTL is responsible for ensuring that all forms are completed fully and properly.

4.5.2 Prior to initiation of field activities, the PM identifies, obtains, and provides the FTL with a copy of various documents, forms, and logs to be used.

4.5.3 The FTL reviews and familiarizes herself/himself with all forms and contacts the PM for clarification of any questions concerning proper completion of the forms.

4.5.4 The FTL brings adequate copies of the appropriate forms to the field site.

4.5.5 Pre-completion of forms is limited to site generic information, e.g., site name and address, and Energy*Solutions* project number.

4.5.6 Although of varying purpose and layout, the following information must be included on all forms: project name and Energy*Solutions* project number; date and time; and the name of the Energy*Solutions* employee completing the form.

4.5.7 As a general rule, all lines, boxes, etc. must be filled out and all queries or prompts answered, i.e., there should be no blank spaces left on the form. If a particular item does not apply write *NA* in the space or otherwise mark appropriately. If you are unsure of how a particular query should be answered, consult other staff members or qualify your answer.

ENERGYSOLUTIONS

Standard Operating Procedure
Collecting Quality Control Samples

Authored By:	Daniel Slywka Name, Title	6/19/2012 Date
Reviewed By:	Robert McPeak Name, Title	6/19/2012 Date
Approved By	Robert McPeak Name, Title	6/19/2012 Date

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1. PURPOSE AND SCOPE

1.1 Purpose

The purpose of this standard operating procedure is to establish guidelines for the collection of quality control (QC) samples and to explain the measures taken to ensure the integrity of each sample collected. The objective of any QC program is to ensure that the data generated are of known and reliable quality. The acceptance of sampling data by regulatory agencies and in litigation-support investigations can depend heavily on the proper QC program to justify the results presented.

1.2 Scope

The QC sampling requirements must be determined based upon the data quality objectives for the project. In some instances, regulatory agencies, such as the USEPA, may specify or provide guidance concerning QC sampling on a project. All QC requirements should be clearly defined in the work plan developed for the project, including types of samples to be collected, sample collection methods, and frequency of sampling. This procedure provides the requirements for the collection of those samples specified in the sampling plan.

2. REFERENCES

2.1 Reference 1: Sample Handling

2.2 Reference 2: Standard Operating Procedure Decontamination of Field Equipment

2.1 Reference 3: Standard Operating Procedure Groundwater Sampling

2.2 Reference 4: Standard Operating Procedure Measuring Water Levels

2.3 Reference 5: Standard Operating Procedure Low-Flow/Low Stress Groundwater Purging/Sampling

2.4 Reference 6: Standard Operating Procedure, Collecting Soil and Sediment Samples

3. GENERAL

3.1 Definitions

3.1.1 *Field Notebook* – A bound book used to maintain records of field activities

3.2 Responsibilities

3.2.1 The Supervisor is responsible for providing the affected employees with this SOP as necessary.

3.2.2 All field employees are responsible for adhering to this SOP when collecting quality control samples.

3.3 Precautions and Limitations

"None"

3.4 Records

3.4.1 Field Notebooks;

3.4.2 Field standard documents

3. QUALITY CONTROL SAMPLES

QC Samples are used to ensure the quality of sampling activities and laboratory performance during an environmental investigation or routine monitoring at a site. Types of QC samples may include field blanks (a.k.a., equipment or rinseate blanks), trip blanks (a.k.a., travel blanks), replicates (a.k.a., duplicates or split samples), matrix spike/matrix, spike duplicates, and performance evaluation samples. A discussion pertaining to each QC sample type is provided below.

3.1 Field Blanks

Description - A field equipment blank (field blank) is collected to check on the sampling equipment handling, preparation, storage and shipment procedures implemented in the field. A field blank is performed by exposing demonstrated analyte-free water (e.g., distilled/deionized water) to the sampling process (i.e., the water must pass through or over the actual sampling equipment). Preferably, the analyte free water should be provided by the laboratory performing the sample analysis. At a selected field location documented in the field book, the water is poured from the full set of bottles through and over the dedicated field sampling device that has been decontaminated for sample collection (e.g., auger flight, split-spoon sampler, trowel, pump or bailer) and into the empty set of laboratory-supplied sample bottles. It is important that the blank be exposed to the entire sampling process, e.g., a field blank for metals should be filtered if the samples were also filtered. Field blanks are generally not required for potable well sampling events or when a sample is collected directly from a source into a sampling container without the aid of any tools. The need for field blanks as a check on the cleanliness of dedicated or disposable sampling equipment (e.g., disposable polyethylene bailers or dedicated bladder pumps) is dependent upon the scope and duration of a project and should be specified in the work plan. Field blanks are usually preserved in the same manner and analyzed for the same suite of parameters as the other samples collected during the sampling event. In some situations it may be advantageous to require equipment blanks for each type of sampling procedure (e.g., split-spoon, bailer, pump).

Field blanks may also be used to detect potential interference or cross contamination from ambient air during sampling events, especially if known sources of contamination are within close proximity or monitoring instruments indicate the presence of contamination above background levels. This field blank is a sample bottle that is filled and sealed with demonstrated analyte free water, and is opened in the field and exposed to the air at a location to check for potential atmospheric interferences. The blank is then resealed and shipped back to the laboratory for analysis.

<u>Frequency</u> - For short-duration sampling events, the rate of one field blank per day is usually sufficient. For sampling events lasting more than a few days, field blanks are generally performed at the rate of between 5% to 10% of the total number samples collected throughout the event.

3.2 Trip Blanks

<u>Description</u> - Trip blanks consist of a set of sample bottles filled at the laboratory with demonstrated analyte free water. These samples then accompany the bottles that are prepared at the laboratory into the field, and back to the laboratory along with the collected samples for analysis. **These bottles should never be opened in the field.** Trip blanks must return to the laboratory with the same set of bottles they accompanied to the field. Trip blanks are primarily used to check for "artificial" contamination of the samples and sample containers during transport to and from the laboratory for analysis. Trip Blanks are typically collected only for VOC analyses.

<u>Frequency</u> - Idealistically, one trip blank per cooler containing VOC samples, or test substance of other analytes of interest, should accompany each day's samples.

3.3 Replicate (Duplicate) Samples

<u>Description</u> - Replicate samples are collected to check on the reproducibility of results either within a laboratory or between laboratories. A replicate sample is called a split sample when it is collected with or turned over to a second party (e.g., regulatory agency, litigant's consulting firm) for an independent analysis.

With the exception of VOCs, obtaining replicate samples in a soil or sediment matrix requires homogenization of the sample aliquot prior to filling sample containers. **Samples taken for VOC analysis however must always be taken from discrete locations or intervals without mixing.** Homogenization of the sample for remaining parameters is necessary to generate two equally representative samples. Note that enough sample must be collected at one time in order to fill all necessary containers. Samples should be thoroughly mixed using a decontaminated stainless-steel bowl and spoon. Once mixing is completed, the sample should be divided in half and containers should be filled by scooping samples alternately from each half.

Replicates of aqueous samples for VOC analysis should be filled from the same bailer or other sampling device whenever possible and be the first set of containers filled. Aqueous replicate samples for other parameters are either obtained from the same sampling device or by alternately filling sample containers from the same sampling device for each parameter.

<u>Frequency</u> - Replicates for determining the reproducibility of laboratory results are commonly collected at a rate of 5% (one for every twenty samples collected). Split samples are at the discretion of the second party and may include every sample collected.

3.4 Performance Evaluation Samples

Description - In certain instances when a laboratory's quality assurance performance is in question, splitting samples may not prove as useful as providing blind performance evaluation (PE) samples to a laboratory since analytical performance and accuracy differs from laboratory to laboratory. Performance evaluation samples provide information on a laboratory's performance based upon analysis of that sample which contains parameters of a known and defined concentration. A PE sample can be used to pre-qualify a laboratory or, if submitted blind with a sample lot, may be used to evaluate the quality of the analytical data. PE samples consist of pre-measured, pre-determined samples of known origin and concentration which are submitted for analysis along with a sample shipment from the field. Deviations from known concentration may indicate improper calibration or other laboratory errors that may have influenced the results reported for those samples collected in the field.

Frequency - Performance evaluation samples are usually required by the governing agency for a project. Therefore, the frequency of submitting these samples to the laboratory is commonly at the discretion of the agency.

3.5 Matrix Spike/Matrix Spike Duplicates

Description -Spikes of compounds (e.g., standard compound, test substance, etc.) may be added to samples in the laboratory to determine if the matrix is interfering with constituent identification or quantification, as well as a check for systematic errors and lack of sensitivity of analytical equipment. Samples for spikes are collected in the identical manner as for standard analysis and shipped to the laboratory for spiking. Matrix spike duplicate sample collection and laboratory spiking and analysis is done to check on the reproducibility of matrix spike results. Prior to sampling, check with the laboratory to determine if additional sample volumes are required for matrix spike/matrix spike duplicate (MS/MSD) samples.

Frequency - The rate for MS/MSDs is almost always one per sample delivery group. A sample delivery group can be defined as either:

- all field samples collected during a project;
- each set of twenty field samples collected during a project; or
- each fourteen calendar day period during which field samples for a project are received by the laboratory (said period beginning with the receipt of the first sample in the sample delivery group),which ever comes first.

4. SAMPLE COLLECTION PROCEDURES

All Quality Assurance samples should be collected using the same procedures to collect normal samples. In addition, the following items must be considered.

4.1 Number of Samples

Determine the type and number of QA/QC samples to be collected as specified in the work plan and implement the sampling as outlined above.

4.2 Concealing Sample Identity

Ensure unbiased handling and analysis of performance evaluation, replicate and blank QC samples by concealing their identity by means of coding so that the analytical laboratory cannot determine which samples are included for QC purposes. Attempt to use a code that will not cause confusion if additional samples are collected in the future.

4.3 Matrix Spike Samples

Label selected matrix spike samples so that the laboratory knows which samples are to be spiked. For projects when only a few samples are collected during a long interval of time, it may be advantageous not to select matrix spike samples until after the samples are received by the laboratory, thus limiting the number of MS/MSDs. In this instance, frequent communication must be maintained between the sampling crew and the laboratory to ensure that an appropriate number of MS/MSDs are analyzed.

4.4 Documentation

Document the QC samples on the appropriate field forms and in the field notebook. On the chain of custody form, fortification, replicate and blank QC samples will be labeled using the codes discussed above and MS/MSDs will be identified as such.

4.5 Sample Handling

Place QC samples in their assigned coolers with the investigatory samples. Refer to Document No. 82A8496 for sample handling and shipping procedures.

ENERGYSOLUTIONS

Standard Operating Procedure Decontamination of Field Equipment

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- [X] Rewrite
- [ ] Cancellation

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Section **Page**

1. **PURPOSE AND SCOPE**

1.1 **Purpose**

The purpose of this standard operating procedure (SOP) is to establish the guidelines for decontamination of all field equipment potentially exposed to contamination during drilling, soil sampling, and water sampling activities. The objective of decontamination is to ensure that all drilling, soil-sampling and water-sampling equipment is decontaminated (i.e., free of potential contaminants): 1) prior to being brought onsite to avoid the introduction of potential contaminants to the site; 2) between drilling and sampling locations/events and activities onsite to eliminate the potential for cross contamination from one borehole/sampling point or well to the next; and 3) prior to the removal of equipment from the site to prevent the transportation of potentially contaminated equipment offsite.

The following SOP is largely adapted from the New Jersey Department of Environmental Protection and Energy's (NJDEPE) *Field Sampling Procedures Manual, May 1992*. However, in determining decontamination procedures on a site-specific basis, state and Federal regulatory and agency requirements and guidance must be considered. Decontamination procedures must be in compliance with state and/or Federal protocols in order that regulatory agency scrutiny of the procedures and data collected do not result in non-acceptance (invalidation) of the work undertaken and data collected.

2. **REFERENCES**

2.1 Reference 1: Standard Operating Procedure Groundwater Sampling

2.2 Reference 2: Standard Operating Procedure Measuring Water Levels

2.3 Reference 3: Standard Operating Procedure Low-Flow/Low Stress Groundwater Purging/Sampling

2.4 Reference 4: Standard Operating Procedure, Collecting Soil and Sediment Samples

3. **GENERAL**

3.1 **Definitions**

3.1.1 External laboratory-grade glassware detergent: Non-phosphate soap such as alconox.

3.2 **Responsibilities**

3.2.1 The Field Team Leader (FTL) is responsible for distributing this and all other applicable SOPs to the employees affected by and expected to adhere to these SOPs.

3.2.2 All Employees are responsible for adhering to this SOP when conducting field sampling of environmental media, unless directed explicitly by regulators or by the Sampling and Analysis Plan (SAP) or by a site specific Work Plan to do otherwise.

3.3 Precautions and Limitations

"None"

3.4 Records

3.4.1 Field Notebook, Varies

4. REQUIREMENTS AND GUIDANCE

4.1 Decontamination of Heavy Equipment

Items such as drill rigs, well casing, auger flights, augers, rods, samplers, pumps, tools, backhoes and any piece of equipment that can potentially come in contact (directly or indirectly) with the sampling matrix should be decontaminated prior to and after each usage during a site investigation (i.e. use only decontaminated equipment). Drilling rigs and associated items mentioned previously should be properly decontaminated by the contractor before arrival on site. Heavy equipment can be steam cleaned or manually scrubbed.

4.1.1 Steam generators and power washers use potable water to provide a high pressure medium to remove visible debris. They are also efficient in terms of ease of handling and will generate low volumes of wash solutions. Potential disadvantages include the need for a fixed or portable power source and water supply and they may not be practical for use on small pieces of equipment or for one day sampling events.

4.1.2 Manual scrubbing involves using a non-phosphate, laboratory-grade glassware detergent solution, followed by a thorough water rinse. This method can be as effective as a steam generator but is labor intensive and generates large volumes of wash and rinse solutions.

4.1.3 Drilling equipment utilized in the presence of thick sticky oils (e.g., PCBs) may need special decontamination procedures before actual steam cleaning or scrubbing.

4.1.4 The wash solutions may have to be contained, sampled and disposed of in a proper manner depending on the type of contaminants encountered and Federal, state and local procedures.

4.2 **Procedure for Non-Aqueous Sampling Equipment**

4.2.1 All equipment should be decontaminated prior to beginning sampling events and after each individual sample is collected.

4.2.2 A location for a decontamination station should be selected. It should be located away from any potential sources of cross contamination. The decontamination station must in no way contaminate an otherwise clean area. Decontamination should be performed over a container and the residual liquid material must be properly disposed.

4.2.3 Wear disposable gloves while cleaning equipment to avoid cross contamination and change gloves as needed.

4.2.4 Disassemble sampling devices and scrub with a brush in a non-phosphate, laboratory-grade detergent and tap water solution to remove visual or gross contamination.

4.2.5 Rinse with generous amounts of tap water.

4.2.6 Rinse with distilled or de-ionized water.

4.2.7 Place clean equipment on a clean plastic sheet to dry (e.g., polyethylene).

4.2.8 Reassemble the cleaned equipment as necessary.

4.2.9 If metal samples are to be collected, an acid rinse (10% nitric acid) followed by a distilled and de-ionized water rinse. If analysis of metals is required and carbon steel sampling devices are used instead of stainless steel, it may be necessary to reduce the nitric acid rinse from 10% to 1% to reduce the leaching of metals from the sampler to the sample. It is then necessary to use a 1% nitric acid rinse after the tap water rinse.

4.3 **Decontamination of Submersible Pumps**

Submersible pumps and wire leads must be cleaned and flushed prior to and between each use according to the following protocol.

4.3.1 Wash pump casing and cable using an external laboratory-grade glassware detergent plus tap water;
4.3.2 tap water rinse;
4.3.3 flush 10-20 gallon of potable water through the pump*;
4.3.4 distilled or de-ionized water rinse;
4.3.5 for submersible pumps with bottom cavities, e.g. Grunfos Rediflo Pumps, the recessed screw at the bottom of the pump must be removed and the cavity should be rinsed out with distilled or de-ionized water and then filled with distilled or de-ionized water; and
4.3.6 pump and wires should be placed on clean polyethylene sheeting.

* For submersible pumps smaller than four inches in diameter, the number of gallons to be flushed can be proportionately reduced (i.e., three inches -- 15 gallons, two inches -- 10 gallons).

Water level meters/indicators and all leads used during groundwater sampling must also be cleaned and flushed prior to and between each use with a laboratory grade detergent plus tap water, a tap water rinse and a distilled or de-ionized water rinse.

All groundwater sampling must be performed using dedicated tubing or new tubing for each well.

ENERGYSOLUTIONS

Standard Operating Procedure
Collecting Soil and Sediment Samples

Authored By:	Dan Slywka	6/19/12
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1. **PURPOSE AND SCOPE**

1.1 **Purpose**

The purpose of this standard operating procedure (SOP) is to establish the procedures for collecting soil or sediment samples.

1.2 **Scope**

These procedures are applicable to surface, subsurface, and stockpiled soil or sediment sample collection with split-spoon samplers, thin-walled tube samplers, hand augers, scoops and other sampling devices.

2. **REFERENCES**

2.1 Reference 1: Standard Operating Procedure, Decontamination of Field Equipment

2.2 Reference 2: Standard Operating Procedure, Collection of QC Samples

2.3 Reference 3: Standard Operating Procedure, Sample Handling

2.4 Reference 4: Standard Operating Procedure, Record Keeping

3. **GENERAL**

3.1 **Definitions**

3.1.1 *Sediment*– a naturally occurring material that is broken down by processes of weathering and erosion, and is subsequently transported by the action of fluids such as wind, water, or ice, and/or by the force of gravity acting on the particle itself

3.1.2 *Quality Control Samples*– Samples collected for analysis which demonstrate the quality of the sample collection and handling procedures which confirm data validity.

3.1.3 *Sample Preservative*– media (such as HCL) placed in the sampling container which preserves the sample and ensures the sample analyzed by the laboratory represents the condition of the sample in the field as closely as possible.

3.1.4 *Chain of Custody*– A form which includes all pertinent information associated with the sampling effort in order to ensure the identification of individual samples and provide confirmation that custody remained in tact and that tampering or substitutions were precluded.

3.2 **Responsibilities**

3.2.1 The Project Manager is responsible for providing the affected employees with this SOP as necessary.

3.2.2 The Field Team Leader (FTL) is responsible for ensuring that the field team complies with this procedure when collecting samples.

3.2.2 All Employees are responsible for adhering to this SOP when recording field activities.

3.3 **Precautions and Limitations**

"None"

3.4 **Records**

3.4.1 Field Notebooks;

3.4.2 Field standard documents

4. CONSIDERATIONS

4.1 General Procedures

Soil or sediment samples can be collected from the surface, shallow subsurface, or at depth interval. Commonly, surface sampling refers to the collection of samples at a 0-6 inch depth; the minimum and maximum depth of surface samples must be defined in the sampling and analysis plan (SAP). Surface soil or sediment samples are usually collected with a stainless steel trowel or scoop. Subsurface samples may be collected with a split-spoon sampler, thin-walled tube sampler or directly from a boring device such as a bucket auger. Subaqueous sediment samples can also be collected with specialized samplers such as Ponar or Eckman Dredges. Borings may be advanced by hand augering, power-assisted hand augering, pneumatic drill, or with a drill rig. In some situations, subsurface samples are collected via excavation with a back hoe or other heavy equipment. When samples are collected at depth, the water content should be noted since "soil sampling" is generally restricted to the unsaturated zone. Sediment samples in many cases will be collected below surface water and will be saturated.

Soil or sediment samples can be collected in either a random (simple, stratified, or systematic) or biased manner. The SAP should not only specify sampling locations and depth, but should also indicate the type of sampling (random or biased) and the reason behind selection of the sampling points in order to allow sampling personnel to make field modifications to the SAP which are consistent with the purpose of the sampling.

4.2 Grab Samples

Either grab or composite samples can be taken. A grab sample is a discrete aliquot that is representative of one specific sample site at a specific point in time. Because the entire sample is collected at one particular point and all at one time, a grab sample is representative of only those conditions. As a rule, when collecting samples at hazardous wastes sites, only grab sampling should be employed.

4.3 Composite Samples

A composite sample is a non-discrete sample composed of more than one specific aliquot collected at various sampling points. Soil or sediment samples may be composited in the field or several samples may be submitted to the laboratory to be composited by weight. The method used is dependent on the regulatory requirements and should be approved and described in the SAP. While compositing samples may have some merit when performed for specific purposes, and under known conditions, the information obtained may not be particularly useful. A commonly used application of composite samples is characterizing stockpiled soils for treatment or waste disposal. To avoid off gassing of contaminants, care must be exercised when composite samples are to be analyzed for volatile organic compounds (VOCS).

5. EQUIPMENT AND MATERIALS

The equipment and materials required for proper collection of soil or sediment samples will be project/site/phase/task specific and will depend upon the techniques and methodologies employed. Sample collection methods, materials, and quality assurance/quality control (QA/QC) requirements should be specified in the SAP. Equipment and materials required for proper collection of soil or sediment samples may include but are not necessarily limited to the following:

- A detailed Sampling and Analysis Plan (SAP);
- field notebook, maps, boring log, and field data sheets;
- containers for investigation derived waste (IDR) as required;
- decontamination supplies including: non-phosphate laboratory grade detergent, buckets, brushes, potable water, distilled water, regulatory-required reagents, aluminum foil, and plastic sheeting, garbage bags.
- SAP specified sampling device(s), e.g., Split-spoon sampler, thin-walled tube sampler, stainless steel hand auger, or stainless steel trowel, etc.;
- stainless steel spoons, spatulas, scrapers, probes and other small tools;
- stainless steel mixing bowl;
- disposable sampling gloves (sterile non-powdered latex or vinyl examination gloves);
- laboratory-supplied and cleaned sample containers;
- sample labels, chain-of-custody/analytical request forms, custody seals;
- sample shuttle/cooler with blue or wet ice;
- zip-lock bags and packing material;
- black pen and indelible marker;
- tape measure;
- paper towels;
- masking and packing tape;
- overnight (express) mail forms.

6. DECONTAMINATION

All sampling equipment should be properly decontaminated prior to use and all reusable sampling equipment should be thoroughly decontaminated immediately after use. Where possible, thoroughly pre-cleaned and aluminum foil-wrapped sampling equipment should be used and dedicated to individual sampling locations and depth intervals. In some cases the use of dedicated samplers may be impractical therefore, when collecting numerous samples, it may be necessary to decontaminate equipment in the field. Disposable items such as sampling gloves, aluminum foil, and plastic sheeting should be changed after each sample is collected and discarded in an appropriate manner.

7. SAMPLING PROCEDURES

1) Determine the type and quantity of sampling equipment required. In cases where it is not known which type of sampling equipment will work best, several types of systems and devices should be on hand and available. Prior to collecting soil or sediment samples, ensure that all sampling equipment has been thoroughly cleaned.

2) Determine the amount of soil or sediment, and the size and number of sample containers needed, prepare preservatives if required, and prepare decontamination equipment and materials if reusable sample equipment is to be used.

3) For subsurface samples, the boring must be advanced with thoroughly cleaned equipment to the top of the desired sampling interval. A pre-cleaned sampling device should then be advanced through the sampling horizon (after removal of the boring tool if required). If the sampling tool is also the boring device, e.g., Bucket auger, the device should be withdrawn and cleaned prior to advancement through the sampling horizon or, preferably, another pre-cleaned device should be used to collect the sample, when possible.

4) Using disposable gloves and a pre-cleaned, stainless steel spatula or spoon, extract the soil or sediment sample from the sampler, and place the sample in a laboratory-supplied pre-cleaned sample container. This should be done as quickly as possible. Samples collected for VOC analysis will typically be collected using EPA Method 5035 sampling procedures which utilize Encore Samplers or preserved vials. These sampling procedures should follow the procedures provided in Section 8. In some cases samples collected for VOC analysis may be collected using other methods. The sampling team should confirm required VOC sampling methods in the sampling plan or with the project manager.

   Samples to be analyzed for VOCS must be collected prior to other constituents and handling should be kept to a minimum. Collect the sample towards the middle of the sampler because soil or sediment at the ends of the sampler may be slough, and therefore not representative of the depth interval being sampled.

5) Label the sample container with appropriate information such as: client name, site location, sample identification (location, depth, etc.) Date and time of collection, and sampler's initials. If samples are extremely contaminated, containers should be placed in individual zip-lock bags and noted as such on the chain-of-custody form.

6) Using the remaining portion of the soil or sediment from the sampler, log the sample in detail by recording: color, odor, moisture, texture, density, consistency, organic content,

layering, grain size, etc. Samples may be screened with portable instrumentation such as a PID or OVA. These results should also be recorded in the field notebook or on the appropriate field data forms

7) Immediately after collection the sample should be cooled to $4^{o}C$ and placed in a cooler/sample shuttle. See sample handling procedures for proper sample handling and documentation.

8) Discard any gloves, foil, plastic, etc. in an appropriate manner that is consistent with site conditions.

9) All reusable sampling equipment must be thoroughly cleaned in accordance with the equipment decontamination procedure. Following the final decontamination, (at the conclusion of the sampling event after all samples have been taken) wrap the sampling equipment in aluminum foil for storage.

8. SAMPLING USING EPA METHOD 5035

8.1 **Sample Collection**

Samples should be collected in a manner that generates an undisturbed sample which comes directly from the soil material. Effort should be taken to collect the sample from coring devices such as split spoon samplers or GeoProbe sleeves as soon as possible after the material has been removed from the ground. Wherever possible the effects of heat wind and rain on the sample should be minimized.

Actual samples collected from the coring device must be collected using a dedicated or decontaminated small diameter sampler.

8.2 **Sample Collection Methods**

Samples may be collected using an Encore Sampler or using a small core soil sampler capable of collecting 5 grams of soil.

The small core sampler must then be able to inject the soil directly into a 40 mil vial. If a small diameter core sampler is used, the sample weights must be measured using a small portable scale and recorded. The weights can be measure by generating a tare weight for the scale and then performing a test weight of the core sampler and the soil material for each soil matrix. Once a 5 gram sample of a specific soil matrix is generated, the volume of this test sample may be used as a guide in collecting the approximately sized small core samples of that soil matrix. Additional test samples should be weighed whenever a change in the matrix is observed.

In order to collect a sample using the small core soil sampler, use the soil matrix test sample as a volume guide. Insert the coring sampler into the undisturbed soil matrix until the same approximate volume as the test sample is in the sampler. Remove excess material adhering to the core barrel, open the sample container and extrude the soil core into the sample container. The sample should be extruded into the vial on an angle to prevent the sample from dropping into the vial and splashing the preservative. Before placing the cap on the vial ensure that all soil particles that might jeopardize the seal have been removed.

8.3 **Sample Preservation**

When collecting samples for use with vials containing required sample preservatives, up to four types of samples may be required. Four separate vials will be provided including: a high concentration sample (methanol preserved), a low concentration sample (water preserved) and sample used to analyze for percent solids. All vials provided by the laboratory must be filled with 5 grams of sample material using the methods described above.

If an Encore type sampler is to be used, for storage and shipment no preservatives are required and one single sampling device is needed per sample. Prepare the sampler for shipment according to the manufacturer's instructions. Remove the cap from the end of the sampler and advanced the sampler directly into the undisturbed soil core. Before replacing the cap on the end of the sampler, ensure that the sealing device and cap are free of soil particles.

Record laboratory and field identification numbers in the field notes and on the chain of custody. After sample collection, place the containers in an iced cooler. Samples should achieve the required temperature of 4^0C +/- 2^0 as soon as possible following collection. Care should be taken to ensure that the cooler arrives at the laboratory within a maximum of 24 hours to ensure the maintenance of the cooler temperature and ensure that the analysis or sample freezing is initiated within 48 hours of collection.

ENERGYSOLUTIONS

Standard Operating Procedure
Low-Flow / Low Stress Groundwater Purging

Authored By:	Daniel Slywka Name, Title	6/19/12 Date
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Section **Page**

1. PURPOSE AND SCOPE

1.1 Purpose

The purpose of this standard operating procedure (SOP) is to establish guidelines for Low Flow or Low Stress Purging of groundwater monitoring wells. As part of the SOP for the purging of groundwater monitoring wells, purging collection equipment must be considered, equipment decontamination, and pre-sampling procedures (e.g., water level measurement, collecting water quality readings, and purging of wells) must be implemented. Sampling objectives must be established in the work plan.

1.2 Scope

The scope of this SOP is to cover the purging techniques and equipment used in the Low Flow or Low Stress Purging of environmental monitoring wells. The scope of the sampling will be established in the site-specific work plan.

2. REFERENCES

2.1 Reference 1 "EPA EQASOP-GW-001 "Low Stress (Low Flow) SOP", Revision Number: 3, Dated July 30, 1996, Revised January 19, 2010"

3. GENERAL

3.1 Definitions

3.2 Responsibilities

3.2.1 The Field Team Leader (FTL) is responsible for distributing this and all other applicable SOPs to the employees affected by and expected to adhere by these SOPs.

3.2.2 All Employees are responsible for adhering to this SOP when conducting Groundwater monitoring, when not directed explicitely by regulators or other specific direction in the Sampling and Analysis Plan (SAP) or a site specific Work Plan.

3.3 Precautions and Limitations

"None"

3.4 Records

3.4.1 Field Notebook, Varies

3.4.2 Groundwater Quality Data Sheets (where required)

4. REQUIREMENTS AND GUIDANCE

4.1 Equipment and Supplies

4.1.1 Informational Supplies, Health and Safety Plan, SAP or work plan, data from previous rounds of sampling (if available), equipment manuals
4.1.2 Well Keys, well opening tools
4.1.3 Pumps, electric submersible, bladder pumps ect.
4.1.4 Appropriate sized tubing for the pump and well size.
4.1.5 Water Level Indicator
4.1.6 Flow Measurement Supplies and stopwatch
4.1.7 Power Source, battery, generator, nitrogen tank, based on pump.
4.1.8 Water Quality Instrument and flow through cell
4.1.9 Decontamination Supplies
4.1.10 Field Notebook and pens
4.1.11 Photo Ionization Instrument (PID)

4.2 Preliminary Site Activities (as Applicable)

a. Check area surrounding wells and curb boxes for evidence of damage or tampering, and record all pertinent observations.
b. Lay out a clean sheet of polyethylene to stage monitoring and pumping equipment on
c. Remove well cap and if appropriate measure VOCs at the rim of the well with the PID
d. Perform water level measurements according to EnergySolutions “Water Level Measurements” SOP

4.3 Low Flow Purging

Purging and sampling of wells in increasing chemical concentrations (if known) is advantageous. The use of dedicated well pumps is recommended to minimize disturbances to the filter pack as well as to prevent potential cross contamination.

4.3.1 Measure the water level prior to installing the pump and tubing, and record in the field notebook
4.3.2 Install the pump to be used to purge and sample the well. Lower the pump slowly and carefully to minimize disturbance, to the appropriate depth (depth previously used in that well or the mid water column depth).
4.3.4 Before starting the pump, re-measure the water level and record this reading in the field notebook. Record water level measurements at three minute intervals to ensure that no more than 0.03 feet of drawdown is maintained during purging.

4.3.5 Start the pumping system slowly and increase the speed until discharge occurs. Check the water level and ensure there are no pumping system leaks. Try to match previous pumping rates with previous rounds of sampling at the subject well, otherwise adjust the pump speed until there is little or no water level drawdown. If the reading indicates that the drawdown at the current rate remains stable and is less than 0.3 feet, continue purging. Monitor and record water levels and pumping rates every 3 to 5 minutes during purging. Record any pumping rate adjustments. If the initial water level is above the well screen, do not let the water level drop below the well screen.

4.3.6 After the water level has stabilized, connect the water quality instrument and flow through cell. If excessive turbidity is anticipated with pump re-start, allow the pump to purge the turbid volume of water prior to attaching the flow through cell. During well purging, monitor field parameters, turbidity, temperature, specific conductance, pH, oxygen reduction potential (ORP), and dissolved oxygen (DO) at 3 to 5 minute intervals. The pumping rate must move enough water to "turn over" the volume of the flow through cell during the measurement interval.

Prior to sampling, stabilization must be achieved in the well when three consecutive readings are within the following parameters:

Turbidity – 10% if values are greater than 5 NTU, if less than 5 NTU, three consecutive readings at less than 5 NTU indicates stabilization
Dissolved Oxygen – 10% if values are greater than 0.5 mg/L, if three consecutive measurements of less than 0.5 mg/L are recorded consider that parameter stabilized
Specific Conductance – three consecutive readings within 3% of each other
Temperature – three consecutive readings within 3% of each other
pH – three consecutive readings within plus or minus 0.1 s.u.
Oxygen Reduction Potential – three consecutive readings within plus or minus 10 millivolts

4.3.7 Once water levels and field parameters have stabilized for three consecutive readings the well is considered "stabilized" and is ready for sampling, refer to EnergySolutions "Groundwater Sampling" SOP for guidance on post purging sampling activities.

ENERGYSOLUTIONS

Standard Operating Procedure
Groundwater Sampling

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1. PURPOSE AND SCOPE

1.1 Purpose

The purpose of this standard operating procedure (SOP) is to establish guidelines for the sampling of groundwater monitoring wells. As part of the SOP for the sampling of groundwater monitoring wells, sample collection equipment must be considered, and equipment decontamination and pre-sampling procedures (e.g., water level measurement, collecting water quality readings, and purging of wells) must be implemented. Sampling objectives must be established in the work plan.

1.2 Scope

The scope of this SOP is to cover the sampling techniques and equipment used in the collection of groundwater samples from environmental monitoring wells. The scope of the sampling will be established in the site-specific work plan.

2. REFERENCES

2.1 Standard Operating Procedure Field Record Keeping

2.2 Standard Operating Procedure Sample Handling

2.3 Standard Operating Procedures Decontamination of Field Equipment

2.4 Standard Operating Procedure Colleting Quality Control Samples

3. GENERAL

3.1 Definitions

"None"

3.2 Responsibilities

3.2.1 The Field Team Leader (FTL) is responsible for distributing this and all other applicable SOPs to the employees affected by and expected to adhere by these SOPs.

3.2.2 All Employees are responsible for adhering to this SOP when conducting Groundwater monitoring, when not directed explicitly by regulators or other specific direction in the Sampling and Analysis Plan (SAP) or a site specific Work Plan.

3.3 Precautions and Limitations

"None"

3.4 Records

3.4.1 Field Notebook, Varies

3.4.2 Groundwater Quality Data Sheets (where required)

4. REQUIREMENTS AND GUIDANCE

The requirements for sampling a monitoring well include the following tasks: measurement of water levels, purging of the well prior to sampling, and sampling of the well.

4.1 Water Level Measurement

Water level readings must be collected from each monitoring well prior to purging and sampling. Water level readings are required to determine groundwater flow direction. Specific equipment is required to obtain the depth to groundwater (DTW) and the Total Depth (TD) of the well. Specific equipment is required to collect water levels, they may include but not limited to, the following;

a. Water Level Indicator
b. Field Notebook to record DTW and TD readings.

4.2 Groundwater Purging and Sample Collection

In order to sample ground water from monitoring wells, specific equipment and materials are required. The equipment and materials list may include, but is not necessarily limited to, the following:

a. pumps (centrifugal, peristaltic, bladder, electric submersible, bilge, hand-operated diaphragm, etc.);
b. appropriate discharge tubing;
c. appropriate compressed gas if using bladder -type or gas-displacement device;
d. portable generator and gasoline or alternate power supply if using an electric submersible pump;
e. plastic sheeting;

f. applicable field forms (e.g., groundwater sampling field worksheet, groundwater pumping field worksheet well inspection worksheet, etc.) and field notebook;
g. well location and site map;
h. stop watch, digital watch with second increments, or watch with a second hand;
i. black pen and water-proof marker;
j. tools (e.g., pipe wrenches, screwdrivers, socket wrench and sockets, hammer, pliers, flashlight, pen knife, etc.);
k. appropriate health and safety equipment, as specified in the site health and safety plan (HASP);
l. Water Quality Meter
m. extra supplies and batteries (for meters, thermometers, flashlight, etc.);
n. disposable gloves; and
o. reference copies of site sampling and analysis plan (SAP) and HASP.
p. Water level indicator

For each sampling event, all field measurement and sampling equipment that will enter a well must be decontaminated prior to its entry into the well.

Calibrate field measuring equipment (e.g., thermometers, pH, conductivity and dissolved oxygen meters, etc.) before use or as required in the manufacturer's manual for the instrument. Document, initial and date the calibration procedures on the appropriate field form, and in the field notebook.

5.0 PROCEDURE

5.1 Purge the well prior to sampling either by the Low-Flow/Low-Stress Method (EnergySolutions SOP "Low-Flow/Low-Stress Groundwater Monitoring Well Purging"), or by the volume adjusted purging method. The well should ultimately be pumped or bailed in accordance with the SAP or site specific work plan.

5.2 If well has been pumped to near dryness, the well should be allowed to recover to a volume sufficient for sampling. In general, sampling should take place within two hours of purging; however, for wells with slow recharge, the two hour limit may be exceeded to allow for sufficient recovery of the water volume.

5.3 Record the physical appearance of the purge water (i.e., color, turbidity, odor, etc.) on the appropriate field form. Note any changes that occur during the purging.

5.4 If a pump is used to collect the sample, then use the same pump used to purge the well. If need be, reduce the discharge rate to facilitate filling sample containers and to avoid problems that can occur while filling sample containers.

5.5 When sampling, remove the cap from each container, pour in the sample and replace and secure the cap immediately.

5.6 Fill each appropriate, pre-labeled sample container carefully and cautiously to prevent: 1) agitating or creating turbulence; 2) breaking the container; 3) entry of, or contact with, any other medium; and 4) spilling/splashing the sample and exposing the sampling team to contaminated water. Immediately place the filled sample container in an ice-filled (wet ice or blue pack) cooler for storage.

5.7 If VOCs are being tested for, then, add additional water for form a meniscus on the water surface within the sample container prior containers and tightly seal with Teflon™-lined septums held in place by open-top screw caps to prevent volatilization. Ensure that there are no bubbles by turning the container upside down and tapping it gently.

5.8 As required, record the start and end time for sampling and the sampling method (e.g., bailer or pump). Measure and record pH, dissolved oxygen, temperature, and specific conductivity, if required.

5.9 Complete all necessary field worksheets and chain-of-custody forms. Secure the cooler with sufficient packing tape and a custody seal for shipment via courier or shipping company.