Permeable Reactive Barrier
Pilot Test Work Plan

Grenada Manufacturing, LLC
Grenada, Mississippi

March 2016

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Section 1 Introduction

1.1 Scope

This Work Plan describes plans for pilot testing at the permeable reactive barrier (PRB) at the Grenada Manufacturing Facility (facility) in Grenada, Mississippi. The pilot test will comprise the following two tasks:

1. Testing to enhance the treatment capability of the PRB by directly placing groundwater within the PRB downgradient of its front face to address reduction of permeability; and
2. Testing enhanced reductive dechlorination (ERD) as a method to remediate groundwater containing chlorinated volatile organic compounds (CVOCs) that appear to be moving toward and possibly around the PRB's south end.

These two activities are presented in a single Work Plan because they will be completed simultaneously.

1.2 Plan Organization

This work plan is organized to initially provide background information regarding investigation work completed on the PRB and present the current understanding of the permeability reduction at the front face of the PRB. A detailed description of the work completed to date is provided in the Supplemental Report (Appendix E) to the 2012 Annual Report. A summary of this work and the findings also is provided in Section 2, along with information developed since the Supplemental Report was submitted in 2014.

Section 3 describes the work associated with the first task of this Work Plan to be conducted to enhance the treatment capabilities of the PRB. As described, the pilot test approach includes bypassing the front face of the PRB through the use of "in-wall" wells that distribute groundwater within the PRB and place it in direct contact with the zero valent iron (ZVI). The primary method to provide complete treatment of the groundwater CVOCs is to enhance the volume of groundwater that contacts the ZVI within the PRB.

The pilot test will assess the ZVI's ability to treat the groundwater and the efficacy of the proposed methods for placing groundwater within the PRB to achieve the necessary residence times to meet treatment goals. The pilot test will also address the use of an ERD zone downgradient of the PRB for treatment in addition to treatment provided by the ZVI.

Section 4 describes the second task of this Work Plan, an enhanced reductive dechlorination (ERD) zone to be established on the PRB's south end to treat CVOC-impacted groundwater. The extent of the area of CVOC-impacted groundwater at the south end of the PRB will be assessed. Based on the area's size, donor substrate will be added to the aquifer to create a zone for ERD treatment of this groundwater. Monitoring will occur to determine the effectiveness of the ERD treatment zone. The monitoring also will serve to determine when additional donor substrate must be added to the aquifer to maintain the ERD zone. Bioaugmentation of the aquifer will occur to ensure that the microbes needed to provide complete dechlorination of CVOCs are present in the treatment zone. The treatment zone, to be created at the PRB's south end, is intended to be an interim measure to treat groundwater until the plume is realigned and captured upgradient of the PRB. The realignment/capture of the plume is expected to occur upon full-scale implementation of work associated with the first task, described above.

Section 5 highlights the quality assurance/quality control activities to ensure that the data collected for the pilot study's two activities meet the objectives of the work plan and provide the information needed for rejuvenation of the PRB's. The data quality objectives are defined, and methods to ensure that the objectives are met are described in this section.

Section 6 presents the proposed schedule for performing the work plan tasks and Section 7 describes the associated reporting of the work and the pilot study results. Section 8 provides references for this Plan.

Section 2 Background

A ZVI PRB was proposed in the CMS as the corrective measure for addressing impacted facility groundwater, and was approved as the facility-wide groundwater remedy by both USEPA and MDEQ. The PRB, installed near Riverdale Creek, was designed to intercept groundwater migrating toward the creek, treat dissolved-phase chlorinated solvent-impacted groundwater (CVOCs) and reduce CVOC concentrations in Riverdale Creek to levels below human health risk and aquatic life criteria. Deed restrictions also were imposed to ensure that other potential pathways to receptors, such as through the use of shallow groundwater at the facility, were blocked.

Designed in 2003, the PRB was installed in 2004 and 2005. The specifications for the design and installation of the PRB are provided in the Design Basis Report (BC, 2003) and the Construction Completion Report (BC, 2006). A summary description of the PRB is provided here.

The PRB is located approximately 100-feet upgradient of Riverdale Creek and is 1,200 feet long (Figure 2-1). The sampling conducted at the time the PRB was designed indicated that its location and length would effectively facilitate treatment of the CVOC plume, with buffer zones provided at the north and south ends of the plume width. The PRB was constructed in 50-foot long panels with concrete "stops" installed ahead of the PRB construction to divide it into 24 panel segments. Each panel segment had an upper and lower panel to correspond to the Shallow and Deep zones of the Upper Aquifer, resulting in a total of 48 PRB panels that were 50 feet wide and 15 to 20 feet top to bottom.

The panels were numbered from north to south and from shallow to deep, such that Panel 1 is the northernmost shallow panel and Panel 25 is the northernmost deep panel. Figure 2-2 shows the PRB in plan view, and its associated monitoring wells. Each PRB panel was sized to treat the concentration of CVOCs considered to be present in groundwater flowing to that specific location within the PRB. The PRB panels varied in thickness (upgradient to downgradient dimension) from 2.5 feet to 6 feet. The ZVI content

of each panel was also varied to match the required level of treatment, from 100 percent ZVI to a mixture as low as 12 percent ZVI and 88 percent sand. Figure 2-3 presents both a plan view and cross section of the PRB showing the individual panels, and the effective thickness and ZVI content of each panel.

The PRB panels were constructed by excavating to the design depth between the concrete stops with a long arm track hoe. The design depth included the following stratigraphy: surficial silty clay soil, the upper and lower zones of the shallow aquifer and the upper two-to-three feet of the Shaley Clay Aquitard separating the Upper and Lower Aquifers at the facility. The trench was held open during the excavation through the use of guar gum slurry. The density and depth of the guar gum were used to prevent collapse of aquifer soils into the trench during excavation. When a given excavation was complete, ZVI and/or a mixture of ZVI and coarse sand were metered into the trench, displacing the slurry. Upon installation of the upper and lower panels, the residual guar gum was broken down to simple soluble sugars by circulating a solution containing an enzyme specific to guar gum degradation. The sugars then migrated downgradient of the PRB panel and provided an electron donor for reductive dechlorination of CVOCs in groundwater between the PRB and Riverdale Creek.

Each PRB panel was designed by Brown and Caldwell (BC) together with the patent holder for ZVI treatment of groundwater, EnviroMetals Technology, Inc. (ETI), to provide enough residence time (or contact time) for the groundwater to interface with the ZVI to allow full breakdown of the CVOCs as the water migrated through the PRB. The estimate of aquifer CVOC concentration at each panel and the rate of groundwater flow were established by BC, and the required residence time (and consequently the required ZVI panel thickness) was established by ETI.

Panel construction proceeded from north to south, and began in the fall of 2004. Once the panels were constructed and groundwater began to flow through the PRB, CVOC treatment commenced. The primary treatment process is the direct dechlorination of CVOCs at the ZVI surface through a corrosion reaction; a secondary process that occurs frequently in conjunction with ZVI is enhanced reductive dechlorination

(with microbes) due to the introduction of an electron donor (the degraded guar gum solution and hydrogen from the corrosion of ZVI). Supplemental panels were installed in the spring of 2005 to ensure that enough ZVI was present to meet the intended design residence time, based upon the results of ZVI emplacement within the PRB (BC, 2006). Figure 2-4 depicts the location of supplemental panels, which were installed on the upgradient side of the PRB.

All construction activities were completed in March 2005. Deep and shallow groundwater monitoring wells were installed prior to PRB construction, including at northern and southern locations. The northern transect includes upgradient monitoring wells MW-45 and MW-46. Monitoring wells MW-41 and MW-42 were placed downgradient of the future PRB location. The southern transect included upgradient monitoring wells MW-51 and MW-52. Monitoring wells MW-47 and MW-48 were placed downgradient of the future PRB location. In each case, the lower numbered monitoring well in the nested pair corresponds to the shallow well. Additional monitoring wells were placed directly into the PRB following installation with the intent of placing the wells approximately in the middle of the PRB at each location. Wells MW-43 and MW-44 (shallow and deep) were installed in panels 9 and 33, respectively (north transect), and MW-50 and MW-49 (shallow and deep) were installed in panels 16 and 42, respectively (south transect).

Initial performance of the PRB was according to specifications. CVOC concentrations declined significantly in wells downgradient of the PRB and in Riverdale Creek. However, a few years after installation, the PRB began to experience hydraulic anomalies. It is now known that the occurrences of such anomalies resulted from a reduction in permeability of the PRB's front (upgradient) face. Details of investigations undertaken to identify the nature and cause of the hydraulic anomalies are provided in the Supplemental Report (Appendix E) to the 2012 Annual Report.

Following the Supplemental Report's submittal, additional work was conducted to further understand the causes of the hydraulic anomalies and identify potential solutions for rejuvenation of the PRB. The work continues and the activities described in this Work Plan are the next steps in the process of rejuvenating

the PRB. The following bullets summarize the work completed since the Supplemental Report was submitted:

1. Test coring of the PRB was completed in May of 2015 at Panels 7 and 8 to further evaluate the potential for placement of "slot-borings" in the front face of the PRB to allow additional flow of groundwater into the PRB. Borings were placed at the approximate location of the front face in Panels 7 and 8 of the PRB and core soil/ZVI samples obtained for laboratory analysis.
2. Cores also were obtained from the interior of the PRB for comparison to the front face cores and for use in laboratory analyses.
3. One of the borings placed in Panel 8 was observed to hit the front face of the PRB as noted by the presence of both zero-valent iron (ZVI) and aquifer sand in the cores. Data logging of water levels at multiple locations in the vicinity of the PRB was used to verify that the front face had been disturbed/crossed by this boring. Water levels in nearby wells declined.
4. Some cores obtained from the front face area of Panels 7 and 8 and from the interior of the PRB were visually logged to characterize the nature of the ZVI and aquifer sand and to look for signs of biofouling and/or chemical precipitation. Evidence of likely biological growth and chemical precipitation was observed in the field.
5. Additional cores were obtained and rapidly sealed within the PVC sleeves (used to retrieve the cores) for later laboratory analysis. A total of 17 3-inch diameter cores, varying in length from 24 inches to 40 inches, were obtained and sealed. The cores were chilled to 4 degrees C and transported to Clemson University (Clemson) for further analysis. Upon arrival at Clemson, the cores were transferred to a cold storage room and maintained at 4 degrees C.
6. Multiple tests have been performed on the cores at Clemson in the laboratory. Tests were performed to evaluate:

- The organic content of the cored material, to assess the quantity of biomass present at various locations near the front face of the PRB and within the aquifer just upgradient of the PRB;
- The extent of chemical precipitation present; and,
- The potential for fines entrainment into the ZVI at the time of installation or subsequent to installation.

7. The work at Clemson has identified more biological material in some locations at the front face of the PRB than was observed in previous (angle boring) cores. A considerably larger content of sulfide precipitates was present in some of the core material. Both of these findings suggest a biological cause for the observed decrease in permeability of the front face of the PRB. Sulfate-reducing bacteria may be using hydrogen generated by the corrosion of the ZVI to reduce sulfate to sulfide, which subsequently combines with dissolved ferrous iron (and possibly other metals) to form stable iron sulfide precipitates. If the sulfate-reducing bacteria can be inhibited or eliminated, the clogging process in slot borings or wells placed in the PRB could be slowed or eliminated.
8. Methods were developed in the laboratory at Clemson for testing the effectiveness of various substances that could be used to control microbial growth on the front face of the PRB, and in slot-borings and wells placed within the PRB. An effective method was developed and tested for completing these tests using microcosm vials and the consumption of a hydrogen food source supplied to the vials.
9. Several substances considered likely candidates for controlling biological growth were tested in the laboratory, and that testing is ongoing. However, effective methods for controlling biological growth appear to have been identified for further testing and final selection at the PRB.
10. Methods that provide more control over groundwater flow into the PRB (in comparison to slot-borings) were designed and tested. A system in which the residence time in a given PRB panel

can be controlled to ensure adequate treatment was determined to be necessary; such control was considered difficult to achieve with slot borings. The selected delivery method involves the use of wells inside the front face of the PRB that are close to the upgradient face. Water is delivered to each well at an independent and controllable rate to match requisite residence times of groundwater in the PRB with the concentration of CVOCs in the influent water.

11. The first set of in-wall wells were installed in Panels 6 through 10 in preparation for pilot testing.
12. The front face of the PRB was mapped in July of 2015 for Panels 6 through 10 to allow placement of wells within the PRB that are close to the front face, but within the wall. In August of 2015, a total of 46 wells were installed and retained for additional testing and full-scale PRB rejuvenation work.
13. The 46 wells were surged and developed to remove fines and prepare the wells for the next round of testing. Injection and extraction tests also were completed on each of these wells with water-level data loggers in place.
14. When the laboratory testing of treatment methods at Clemson is compete, the most promising treatment/biological inhibitor methods will be selected and tested on the in-wall wells. The ability to inhibit the biological processes and to maintain flow to the in-wall wells will be tracked over time. The residence time in the PRB and treatment efficiency also will be pilot tested.

Work continues at Clemson to better define the methods to be used in the upcoming pilot tests, and is described in the next section of this report. Appendix A contains well construction logs for monitoring wells installed in and around the PRB.

Section 3 PRB Rejuvenation Pilot Test

As discussed, over time, the permeability of the front (upgradient) face of the PRB has decreased. The testing completed to date indicates that the interior of the PRB appears to remain permeable and also capable of abiotically degrading CVOCs present in groundwater. The key requirement now is the placement of groundwater in contact with ZVI in the interior of the PRB and maintaining sufficient residence time to enable complete treatment of the CVOCs.

In-wall wells have been placed close to the front face of the PRB, but in the interior of the PRB, that will allow the injection of plume groundwater directly into the PRB. A total of 49 wells were installed in 10 PRB panels (of 48 total panels). Three of the 49 wells subsequently were abandoned because it was suspected that the wells had penetrated the front face of the PRB. In this rejuvenation scenario it is undesirable to allow groundwater to pass the front face in an uncontrolled manner; wells penetrating the front face would provide such an uncontrolled pathway.

The remaining 46 wells were tested in the fall of 2015 to determine whether injected groundwater could be accepted and to better evaluate the expected flowpaths within the PRB as water is injected into each in-wall well. Prior to the injection of water into the test well, water level data loggers (Divers®) were placed in the wells completed in the same panel segment and in piezometers located upgradient and downgradient of the panel being tested. The water levels in the test well and in the other wells equipped with Divers® were logged through the period of groundwater injection and subsequent recovery following the injection. Groundwater transport modeling will be completed, as described in this Plan, to assess the flowpath that groundwater likely will take in the tested panel and to estimate the residence time groundwater will remain in a given panel based on flow characteristics. The calibrated groundwater flow model for a given panel will be used to optimize the injection rate and frequency for each in-wall well.

Panels 9 and 33 (panel segment 9) will be used in the initial pilot test work to verify that the ZVI in the interior of the PRB remains sufficiently reactive to degrade the CVOCs in groundwater, given a specified

residence time. The intent of the groundwater injection in panels 9 and 33 will be to closely match the residence time to the level of CVOC impact and to monitor the effectiveness of the PRB at reducing the CVOC concentration in the injected groundwater.

An enhanced reductive dechlorination (ERD) zone will be established downgradient of the panel 9/33 area to treat residual CVOCs that may escape treatment in the PRB during the first phase of the pilot test. It also will be used during the second phase to test the maximum groundwater treatment capability of the PRB in conjunction with an ERD zone. Expansion of this approach to additional panels is expected if the pilot testing is successful.

The pilot test also will evaluate whether the processes that have led to permeability loss in the wall's front face can be stopped and similar permeability loss in the in-wall injection wells prevented. Work completed to date suggests that denatured ethanol, applied periodically to the wells, may inhibit the microbes that likely are facilitating the permeability loss. Some of the injection wells will be periodically treated with denatured alcohol while others will remain untreated. The relative loss of permeability in the two groups will be compared to evaluate the denatured alcohol effectiveness at slowing or stopping the processes that lead to a permeability loss in the panels.

The remainder of this section is divided into subsections that describe the three main subtasks of the pilot test work:

(1) Modeling groundwater flow within the panels;

(2) Performing the pilot test to determine if the existing ZVI is capable of achieving effective abiotic treatment of CVOCs within the PRB; and

(3) Continuing testing described in #2 at a higher flow rate to define an optimal (higher) groundwater injection rate that utilizes the abiotic degradation of the ZVI in conjunction with a downgradient ERD zone to treat CVOCs in groundwater.

3.1 PRB Panel Modeling

Data obtained from the in-wall well injection testing completed in the fall of 2015 will be used to calibrate a model for each shallow/deep panel pair (panel). This model will be used to predict flowpaths within the panels and the resultant average residence time for groundwater injected into the panels. The calibrated model then will be used to optimize the rate and frequency of groundwater injections at panels 9 and 33 to meet the design residence time in the PRB necessary to achieve the requisite groundwater treatment during the pilot test.

The modeling work will be competed using MODFLOW, a finite difference groundwater flow model, and MODPATH to simulate advective groundwater flow through a particle tracking routine. Automatic parameter optimization with adjustments to hydraulic conductivity within the panel model cells will be used to calibrate the model to field data obtained in the testing described in Section 3.0.

The primary purpose of the modeling is to develop an injection strategy that maximizes residence time. Using that injection strategy, the volume and frequency of groundwater injections will be varied for each well based on groundwater modeling results. Moreover, field results from the pilot test described in Section 3.2 below will be used to determine the true in-situ reactivity of the ZVI. This information will be used in conjunction with the panel models to ensure that the groundwater receives the design level of treatment.

The results and calibration statistics of groundwater modeling for each panel will be reported as indicated in Section 6.

3.2 PRB Rejuvenation Pilot Testing

A method for increasing the flow of groundwater through the ZVI PRB will be pilot tested on panels 9 and 33, as described below. The pilot test will consist of an initial phase designed to identify the flow rate of

groundwater at specified trichloroethene (TCE), cis-1,2-dichloroethene (cDCE) and vinyl chloride (VC) concentrations that can be effectively treated by the PRB. The pilot test will include a controlled injection of groundwater in identified locations at in-wall wells using a specified rate and injection interval. This method of groundwater injection into the PRB will allow for a high level of control over groundwater flow and residence time within treatment zones to provide near complete treatment of CVOCs within the PRB. The following discussion describes the methods to be used to carry out the pilot testing.

The pilot test will be performed on the upper and lower panels (panels 9 and 33) at the north transect in the PRB. No distinct division exists within the PRB between the upper and lower panels. However, in many instances more iron was installed in either the upper or lower panel in anticipation of a greater CVOC concentration in the upper or lower zone of the aquifer at that location. Testing completed in the in-wall wells has shown that little hydraulic separation exists between the upper and lower panels. The primary hydraulic separation that exists within the PRB is between adjacent panel sections (upper or lower). A concrete stop was placed every 50 feet within the PRB that divides PRB segments into panels. In this Plan, the upper and lower panels of a single PRB segment (between concrete stops) will be described as a single PRB panel and named based on the number of the upper panel. In this case, panels 9 and 33 are to be tested, but they will be described as PRB segment 9 in this Plan.

Figure 3-1 shows the location of the in-wall wells in Panel 9 and the existing and proposed monitoring wells for the pilot test. A total of nine in-wall wells are present in this panel, four deep and five shallow. This panel also contains the two in-wall monitoring wells that were installed in 2004 as monitoring points within the north transect (MW-43 and MW-44).

A plan for placing groundwater into the nine injection wells will be developed as a part of the work described in Section 3.1. However, the overall rate to be injected into the panel will be selected based on the concentration of TCE, cDCE and VC in the groundwater being injected, and the iron content of segment 9. The goal is to provide a flow rate to this segment that is consistent with its groundwater treatment capability. The flow rate will be determined using the ZVI treatment efficiency from the PRB design,

the ZVI content of segment 9 and the residence time of the injected groundwater within segment 9. Of these factors, the variable within our control is the residence time of groundwater in segment 9. This variable is controlled by the rate and timing of groundwater injections into the panel.

To better track groundwater flow in the pilot test areas, bromide will be added to the injected groundwater. The target concentration for the bromide tracer in the injected groundwater is 50 mg/L. This concentration is significantly higher than the background concentration of bromide in groundwater, which has been found to be non-detect. Bromide is a conservative tracer in this environment. It is non-reactive and non-adsorbing, and provides a good method to track the movement of groundwater through the pilot test area.

Monitoring for the pilot test will consist of groundwater samples collected weekly from wells A-9DN, A-9D and A-9DS. The injected groundwater will also be monitored weekly during the test. The parameters to be tested will include at least VOCs, dissolved oxygen (DO), oxidation reduction potential (ORP), pH, conductivity, bromide, sulfate, alkalinity and arsenic. Sampling methods and quality control are discussed in Section 5. Pilot test reporting is described in Section 6.

3.3 Downgradient ERD Pilot Test

An enhanced reductive dechlorination (ERD) zone will be established downgradient of PRB segment 9 to treat residual CVOCs. The installation and testing of this ERD zone will constitute the second phase of the PRB rejuvenation pilot test. Its purpose is to help determine the quantity of groundwater that can be effectively treated by a combination of ZVI and ERD, and to optimize the process. If the initial pilot testing is successful, its expansion to additional panels is expected.

Figure 3-1 shows the well locations that will be used to place emulsified vegetable oil (EVO) into the aquifer in a zone downgradient of the PRB. These wells are labeled EVO-1 through EVO-7 on the figure. EVO will provide a long-term electron donor for the biological breakdown of CVOCs to ethene and ethane. The wells also will be used to bioaugment the treatment zone with microbes having the known capability to

degrade CVOCs to ethene/ethane. The consortium of microbes to be injected includes Dehalococcoides ethenogens (DHC), which is the only microbe known to facilitate complete reductive dechlorination of CVOCs to ethene. Other members of the consortium aid DHC in the degradation process by carrying out such functions as EVO fermentation to hydrogen, which is the primary food source for DHC.

Groundwater will be extracted from alternate wells within the line of EVO wells, amended with EVO at a specified dosing rate, periodically amended with bioaugmentation culture and reinjected into the adjacent set of EVO wells. EVO and the microbes will be pulled between adjacent wells (extraction and injection wells) to distribute both EVO and the microbial consortium with the line defined by the EVO wells. After breakthrough of the EVO occurs at the extraction wells, the groundwater flow direction will be reversed between adjacent wells to provide effective coverage of EVO and bioaugmentation culture throughout the line of EVO wells.

Groundwater flowing downgradient of PRB segment 9 will be treated as it moves through the ERD treatment zone. As described in greater detail in Section 3.4, the electron donor for this process will be a combination of the EVO injected for the pilot test, residual hydrogen from the corrosion of iron in the PRB and denatured alcohol that will be used to help maintain the permeability of the in-wall injection wells.

The groundwater injection rate into the PRB wells will be increased to an optimal rate that combines treatment with ZVI and ERD in a sustainable manner. Groundwater injections will continue at this optimal rate to demonstrate the overall treatment capability of the system and the sustainability of the process. The specific injection rate will be determined during the test to correspond to the treatment capability of the ZVI in combination with ERD treatment using residual ethanol (described in Section 3.4) and hydrogen produced by the PRB as the electron donor sources for the ERD treatment.

Groundwater monitoring will continue at wells A-9DN, A-9D and A-9DS just downgradient of the PRB and at well B-9D downgradient of the ERD zone. The first line of wells will measure the treatment efficiency of the ZVI at the higher flow rate, and well B-9D will measure the combined treatment efficiency of the combined system. As with the first phase of the pilot test, groundwater samples will be collected weekly

and tested for the parameters listed in Section 3.3, with the addition of methane, ethane and ethene (MEE), and arsenic. Throughout the pilot test, field parameter measurements (DO, ORP, conductivity and pH) will be completed in wells MW-43 and MW-44 to evaluate conditions within the PRB.

3.4 In-Wall Well Treatment

Prior to commencing groundwater injections into the in-wall wells in segment 9, each well will be treated with denatured alcohol to disrupt the biological processes that may develop while groundwater injection is underway. The actual processes that are of concern (e.g., sulfide mineralization) that likely led to the PRB front face permeability reduction are described in Section 2 above and in the Supplemental Report.

Laboratory testing is still ongoing to determine the optimal concentration of denatured alcohol for well treatments. The optimal concentration of alcohol will be injected into each well (during a given treatment event) to provide the desired biofilm disruption and microbial inhibition. The alcohol/groundwater mixture will remain in the well for a period of 4 to 24 hours, depending on laboratory results and the groundwater injection schedule. The specific concentration and duration of the treatment will be determined once the laboratory testing is completed and the results are analyzed.

Denatured ethanol will be added slowly to a given well as the groundwater in the well is circulated. Alcohol additions will continue until the desired alcohol concentration is achieved. A hydrometer will be used to test the contents of the recirculation loop to determine when the appropriate alcohol concentration is present. After the desired exposure time has occurred, groundwater injections will resume at a given well and the injected groundwater will move the alcohol away from the well and, ultimately, into the groundwater stream downgradient of the PRB. The residual alcohol will act as an electron donor for reductive dechlorination of any remaining CVOCs within the ERD zone described in Section 3.3.

Each in-wall well will receive follow-up treatments with alcohol at a frequency to be determined initially by laboratory testing, and will later be adjusted in the field based on backpressure observed during routine groundwater injections.

Section 4 PRB South End Work

The reduced permeability of the front face of the PRB and resulting changes in the wider flow field approaching the PRB have caused groundwater to move toward, and possibly around, the south end of the PRB. An objective of this work is to identify how far to the south the groundwater plume has shifted and to install an ERD treatment zone at the PRB's south end to degrade the CVOCs to the harmless byproducts ethene/ethane before the groundwater discharges to Riverdale Creek.

4.1 Identifying the Extents of the Bypass Zone

Figure 4-1 provides the proposed layout of wells at the south end of the PRB that will be used for this pilot test. Wells TW-301 through TW-304 will be installed initially. These wells will be sampled and analyzed for VOCs. The sample from TW-304 will be analyzed with a rapid turnaround to enable field decisions regarding whether to extend the line of wells further to the south. If TW-304 is impacted with CVOCs above the maximum contaminant levels (MCLs), the line will be extended further to the south with wells at a similar spacing interval until a boundary of groundwater with all CVOCs below the MCLs is reached.

4.2 EVO Treatment Zone

When the southern edge of the treatment zone has been defined as indicated in Section 4.1, EVO wells will be installed 15 feet on center to the outer edge of the zone of impacted groundwater. The location of the first few EVO wells is shown on Figure 4-1. As noted, additional wells will be added to the south as needed.

EVO will be added to the wells in the manner described in Section 3.3, except the EVO mix will include a pH buffer to aid in temporarily increasing the pH of the treatment zone for the reasons discussed below. Following placement of the EVO, the wells will be sampled after approximately two weeks to determine if

the aquifer is sufficiently reducing to allow placement of the bioaugmentation culture. Once it is verified that conditions are favorable for the survival of the bioaugmentation culture, the culture will be added to the EVO wells and circulated between wells to achieve coverage through the treatment zone.

The selected bioaugmentation culture, which is maintained by Clemson University, was adapted for its ability to achieve full reductive dechlorination in lower pH groundwater. Most bioaugmentation cultures lose effectiveness when the pH in the treatment zone drops below approximately 6.0. The Clemson culture reportedly is capable of maintaining robust dechlorination at a lower pH. Shallow groundwater at the facility and throughout the surrounding region typically has a low pH. The pH of groundwater near the south end of the PRB has varied between 5.5 and 6.0 standard units (S.U.) in recent monitoring events. When donor is added to the aquifer, it is expected that the pH will decline further, although the actual decline in pH is difficult to predict ahead of in-situ testing. The pilot test will inform us whether the Clemson bioaugmentation culture can withstand this expected decline in pH.

4.3 Monitoring Bioaugmentation Effectiveness

Following bioaugmentation, the EVO wells will be sampled periodically to verify that a sufficient electron donor still is present in the treatment zone for effective ERD treatment. The groundwater samples will be analyzed for DO, ORP, pH, conductivity, alkalinity and TOC. If it is determined that the ORP is rising or is no longer conducive to ERD, more donor will be added. A soluble donor may be used in conjunction with EVO if there are problems maintaining low ORP conditions in the aquifer and/or there are pH-related issues.

The pH will be monitored closely in the treatment zone. If the pH drops below 5.0, actions may be taken to help raise the pH to aid in the establishment of full reductive dechlorination in the aquifer. For example, groundwater may be extracted from a zone downgradient of the PRB and reinjected in the treatment zone to aid in stabilizing the pH. Thus, such an action should effectively increase the pH, because this zone has shown higher pH than the aquifer in general. The higher pH in groundwater downgradient of

the PRB is due to the ZVI corrosion process, which increases the pH of groundwater as it passes through the PRB.

Two wells in the line of monitoring wells installed to identify the edge of the zone of impact (TW-300 thought TW-306) on the south end of the PRB will be selected to monitor the effectiveness of the ERD. Groundwater samples will be collected as described in Section 5 and analyzed for VOCs, TOC, sulfate, alkalinity, arsenic, DO, ORP, pH, conductivity and MEE. The wells will be sampled weekly for the first four weeks of the test and monthly thereafter until it is determined that the treatment at the south end of the PRB is no longer needed. Additional EVO injections will be made if dechlorination activity declines and/or if the reducing conditions in the treatment zone increase (ORP above -75 millivolts).

Arsenic will be monitored due to the known effect of reducing conditions in mobilizing naturally occurring arsenic from aquifer soils. This effect has been shown to occur to a limited extent with groundwater downgradient of the PRB; thus, it may occur to some extent with ERD. While arsenic has been present in groundwater downgradient of the PRB due to the reducing conditions, it has not been detected at elevated levels in Riverdale Creek or in the creek sediment. The arsenic likely precipitates back into the aquifer soils as the groundwater becomes more aerobic downgradient of the PRB. Nonetheless, arsenic levels will be monitored, both in groundwater and in the creek, to verify that they remain within acceptable ranges.

Section 5 Quality Assurance/Quality Control

Field and sampling activities will be performed in accordance with the Quality Assurance Project Plan (QAPP) for the Corrective Measures Monitoring and Equalization Lagoon Post-Closure Monitoring (BC, 2006). The quality assurance/quality control (QA/QC) protocols and procedures in this Work Plan supplement the above-referenced QAPP for the additional sampling and investigation methods (e.g., bromide tracer test) not included in the existing QAPP.

5.1 Data Quality Objectives

Data Quality Objectives (DQOs) are qualitative and quantitative statements that specify the quality of the data required to support decision-making during closure activities, and are based on the end uses of the data to be collected. Thus, different data uses may require different levels of data quality. There are five analytical levels that address various data uses and the QA/QC effort and methods required to achieve the desired level of quality. These levels are:

- Screening (DQO Level 1): This level provides the lowest data quality, but the most rapid results. It often is used for health and safety monitoring, preliminary comparison to Applicable or Relevant and Appropriate Requirements (ARARs), initial site characterization to locate areas for subsequent and more accurate analyses and for engineering screening of alternatives (bench-scale tests). These types of data include those generated on-site through the use of PID, pH, conductivity and other real-time monitoring equipment at the facility.
- Field Analyses (DQO Level 2): This level provides rapid results and better quality than in Level 1. It may include mobile laboratory or field gas chromatography-generated data, depending on the level of quality control exercised.
- Engineering (DQO Level 3): This level provides an intermediate level of data quality and is used for site characterization. Engineering analyses may include mobile laboratory or field

gas chromatography-generated data and some analytical laboratory methods (e.g., laboratory data without full quality control documentation).

- Conformational (DQO Level 4): This level provides the highest level of data quality and is used, for example, for purposes of risk assessment. These analyses require data validation procedures in accordance with EPA recognized protocols, approved analytical methods and analytical detection limits.
- Non-Standard (DQO Level 5): This level refers to analyses by non-standard protocols, for example, when exacting detection limits or analysis of an unusual chemical compound is required. These analyses often require method development or adaptation. The level of quality control is usually similar to DQO Level 4 data. No sampling or analysis for this project will use DQO 5.

The QAPP addresses soils and/or groundwater sampling and potentiometric surface measurement in monitoring wells, which includes the following investigative tasks:

- Soils and/or groundwater sampling with a drill rig to delineate CVOCs:
    - Allows for submission of analytical samples for direct comparison with current or historical soil or groundwater monitoring well data. Soil and groundwater samples collected with conventional Geoprobe methods will be analyzed at a fixed base laboratory and the analytical results will be at DQO Level 4;
    - Allows for chemical speciation. Analytical work to be completed at DQO Level 4.
- Potentiometric surface measurement in borings will be completed at DQO Level 1.
- Potentiometric surface measurements from existing and new temporary monitoring/injection wells with surveyed top of casing (TOC) measurements will be completed to DQO Level 4.
- Survey of installed monitoring and injection wells and investigation locations will utilize DQO Level 4;

- Sampling of groundwater from Panel 9 Pilot Test wells to assess groundwater ZVI groundwater treatment will utilize DQO Level 1;
- Sampling of groundwater from bioaugmentation wells to assess ERD treatment of groundwater supplemental to PRB treatment will utilize DQO Level 1;
- Refinement of potential groundwater flowpaths that may act as contaminant transport pathways will utilize DQO Level 2;
- Refinement of the facility's stratigraphy and presence/absence of the Intermediate Clay will utilize DQO Level 2; and
- Installation and sampling of wells for purposes of CVOC delineation and potentiometric data will utilize DQO level 3.

The investigation will follow the methods and protocols set forth in the QAPP for these tasks.

The precision, accuracy, representativeness, comparability, completeness and sensitivity of the Pilot Test procedures must be adequate to allow the data to be used for:

- Assessment of pre-test background conditions;
- Delineation of constituents of concern in groundwater through contaminant mass measurement and determination of groundwater flowpaths;
- Determination of the volume and frequency of groundwater and/or amendment injections;
- The effectiveness of ZVI treatment; and,
- The effectiveness of ERD treatment.

The procedures to be used to assure that data meets the above-listed DQOs are detailed further in Section 5.2 below.

5.2 Field Instrumentation

Field Instrumentation is expected to include:

- Photo-ionization detector (PID) for health and safety monitoring and headspace screening;

- Draeger Tubes™ (or equivalent) to allow for chemical speciation for TCE to support health and safety monitoring or field screening;
- Meters to measure temperature, pH, specific conductance, redox, dissolved oxygen (DO) oxidation/reduction potential (ORP) and turbidity in groundwater; and
- Water level tapes to measure depth to water in boreholes or monitoring wells.

Field instrumentation will be calibrated, used and maintained in accordance with the manufacturer's instructions, the QAPP and Site-Specific Health and Safety Plan (T&M, 2015).

PIDs used for headspace and health and safety monitoring will be equipped with an 11.7 eV lamp. Each instrument will be calibrated to NITST traceable calibration gas of 100 ppm isobutylene.

5.3 Soil Sampling

Soil sampling will occur in accordance with the procedures and methods set forth in the QAPP and supplemented with procedures described in this Work Plan, and in the T&M SOPs provided in Appendix B of this Work Plan.

5.4 Temporary Well Installation

Temporary wells, monitoring wells and injection wells will be installed in accordance with the applicable T&M SOP provided in Appendix B.

5.5 Groundwater Sampling

The measurement of water levels, purging of wells and groundwater sampling will occur in accordance with the procedures and methods set forth in the QAPP.

Vertical profile sampling within a screened interval of a temporary well may be performed in accordance with the T&M SOP provided in Appendix B. Such vertical profiling may be used to define higher concentration groundwater flow streams.

The analytical methods, sampling requirements including container, requisite sample volume, preservation and holding time are provided in Table 5-1. The Quality Assurance procedures for both TestAmerica and Pace Laboratories are included as Appendices C and D, respectively.

Table 5-1 Groundwater Sampling, Collection, and Holding Time Requirements

Parameter	Method	Container and Minimum Sample Volume	Preservation	Holding Time
Volatile organic compounds	SW-846 Method 8260 B	40 ml VOA; Filled with no headspace	HCl	14 days
Total organic carbon	SW-846 Method 9060	40 ml VOA; Filled with no headspace	HCl	28 days
Sulfate	SW-846 Method 9056A	Unpreserved poly; minimum of 100 ml (same container as bromide)	None	28 days
Bromide	SW-846 Method 9056A	Unpreserved poly; minimum of 100 ml (same container as sulfate)	None	28 days
Methane, ethane, ethene	RSK_175 (TestAmerica); AM20GAX (Microseeps)	40 ml VOA; Filled with no headspace	HCL (TestAmerica); Sodium Thiosulfate (Microseeps)	14 days

5.6 Survey

Investigation locations, injection wells and monitoring wells will be staked and labeled for survey by a professional surveyor.

The survey will occur following the procedures and methodology set forth in the QAPP. Each boring and well top of casing will be surveyed to the following tolerances:

- 0.1 feet in the x and y-axes; and
- 0.01 feet in vertical axis.

All surveying will be performed by a Professional Surveyor registered in the State of Mississippi.

5.7 Analytical Laboratory

Sample procedures and methodology include, but are not limited to, labeling, handling, staging, packaging, chain-of-custody procedures, sample shipping, analytical methods and procedures, including QA/QC, will follow the protocols in the QAPP. The analytical laboratories to be used for groundwater and soil sample analyses, as needed, with be TestAmerica Labs, Inc. and Microseeps, Inc.

5.8 Decontamination and Investigation-Derived Waste (IDW)

Non-disposable field equipment, such as non-dedicated sampling or down-hole tooling and equipment, will be decontaminated between each sampling location following the procedures outlined in the QAPP. Drill tooling will be decontaminated after use with a scrubbing wash of phosphate-free potable water, a scrubbing rinse with potable water and a spray rinse of potable water. Alternatively, a power washer or steam cleaner may be used to spray potable water. All decontamination rinseate will be containerized and drummed as investigation-derived waste (IDW).

Purge water, decontamination water, soil cuttings, personal protective equipment and disposable sampling equipment (i.e., tubing, bailers, sheet plastic, etc.) generated during the sampling event will be placed into Department of Transportation (DOT)-approved 55-gallon steel drums and staged at the T&M storage shed in proximity to the PRB. Each drum will be labeled with its contents and date of generation, as required for proper storage. Groundwater analytical results will be evaluated to characterize the purge water for transportation and disposal by a licensed waste hauler. Disposal of IDW will follow federal and state regulations.

Section 6 Schedule

The pilot test work will be initiated upon approval of this Work Plan. It is anticipated that well installation and pilot test set-up will occur over a period of one month following mobilization to the facility. The first phase of the PRB rejuvenation pilot test (ZVI testing phase) will be completed over a period of approximately one month. The second phase of the PRB rejuvenation pilot test (ERD testing) will occur over a six-week period following completion of the first phase. If the testing successfully demonstrates that the PRB can treat groundwater in the proposed manner, the test system will be expanded to the remainder of the panels where wells already have been installed (segments 6 through 10).

Initially, the ERD work at the south end of the PRB will occur in parallel with the PRB rejuvenation pilot test. This work then will transition, as necessary, into a longer-term treatment plan that will continue until it is determined that CVOCs are not bypassing the south end of the PRB.

Field activities for the pilot test will be coordinated to enable activities such as well installation, EVO injections, bioaugmentation, surveying and monitoring to occur at similar times. T&M will provide estimated dates for primary mobilization and schedule updates, as needed, to enable EPA to plan its oversight activities.

Section 7 Reporting

Following the completion of the two-month monitoring period for the PRB rejuvenation pilot test, a report will be prepared summarizing the methods and results of the pilot test. The report will be submitted to EPA six weeks following the completion of the pilot test.

The report will include:

- Well construction diagrams and location maps of all wells installed for the test;
- Boring logs;
- Modeling results for the PRB segment 9 with projections regarding the average residence time expected under various groundwater injection scenario;
- Model calibration details, sensitivity analyses, and water level data used to calibrate and validate the model;
- Validated laboratory data packages (note that data will be uploaded to the Region 4 EQuIS database when data validation is complete);
- Data summary tables; and
- Information regarding quantities of amendments placed in the aquifer for ERD and the quantities of bioaugmentation culture injected in the treatment zone.

The report also will include information and data obtained from the PRB south end pilot test, although that pilot test is expected to continue beyond the time that the report is submitted. The following information from the work at the south end of the PRB will be included in the report:

- Monitoring well and EVO well installation records and construction diagrams;
- Boring logs;
- Plan maps with final boring and well locations and elevations;
- A figure showing any CVOC bypass on the south end of the PRB, as applicable;
- Information regarding the quantity of EVO injected in each well and recirculation times;

- The quantity and type of bioaugmentation culture ingested, aquifer conditions at the time of injection and recirculation times;
- All laboratory data packages obtained and validated at the time of report preparation;
- Field monitoring data;
- Data summary tables; and
- Plots of monitoring results, as appropriate.

Section 8 References

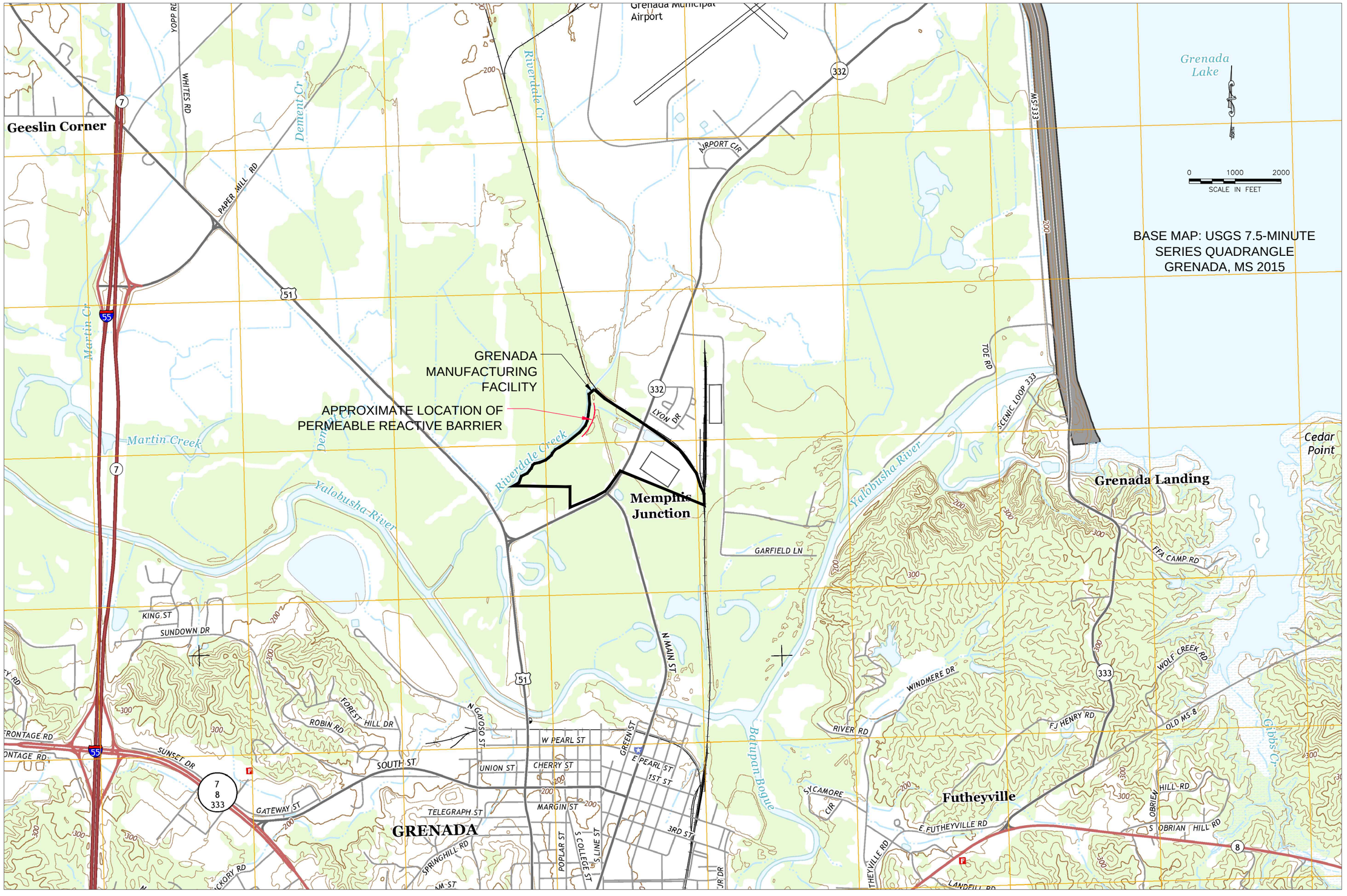
Brown and Caldwell, (2003). Design Basis Report.

Brown and Caldwell, (2006). Construction Completion Report.

Brown and Caldwell, (2006). Quality Assurance Project Plan for the Corrective Measures Monitoring and Equalization Lagoon Post-Closure Monitoring.

T&M Associates Supplemental Report (Attachment E) to 2012 Annual Report.

Figures



T AND M
4675 LAKEHURST COURT
SUITE 250
COLUMBUS, OHIO 43016
TEL 614-339-3380
WWW.TANDMASSOCIATES.COM

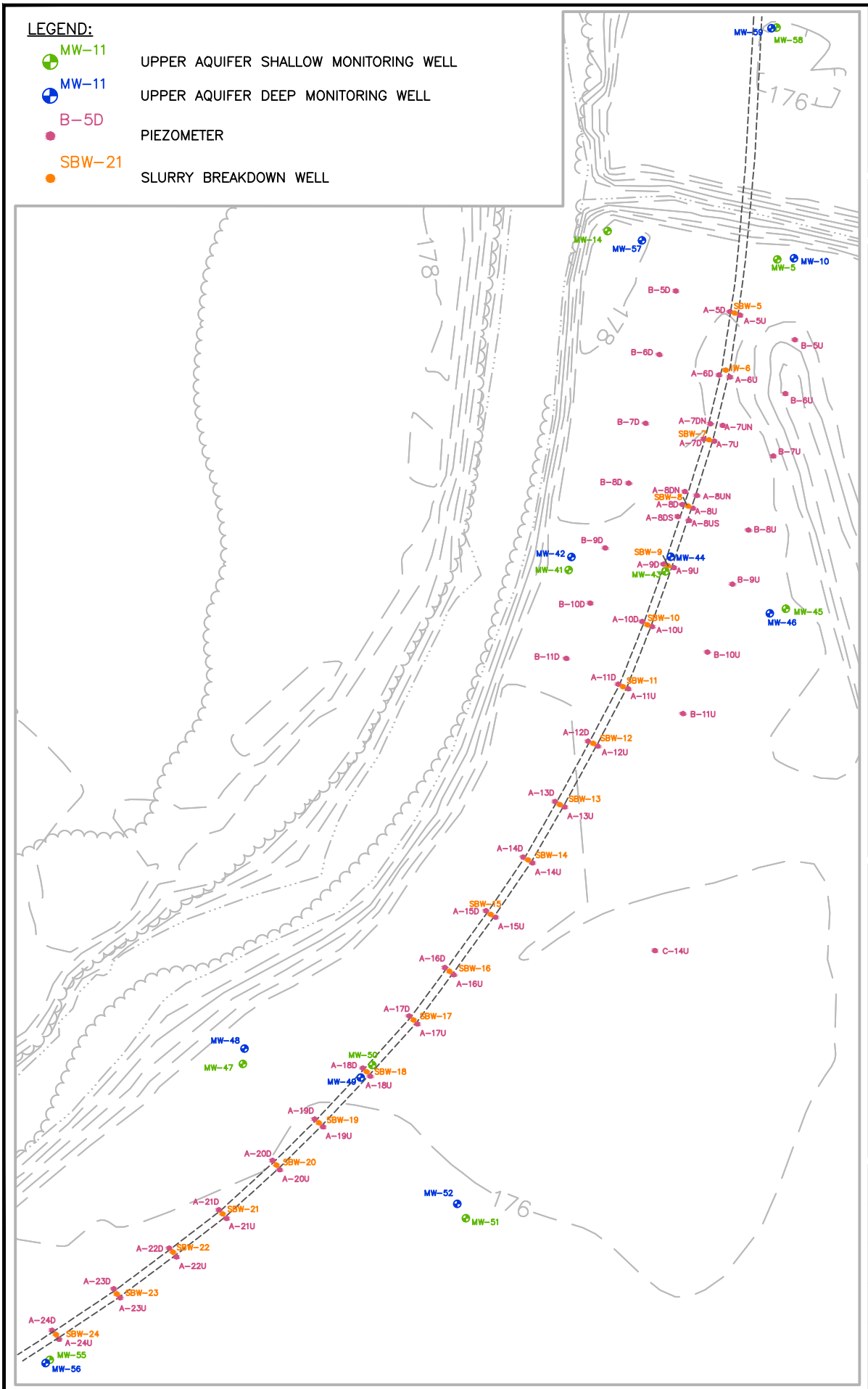
SITE LOCATION MAP

NO.	DATE	REVISIONS	BY	CHECKED

PROJECT NO. MERT010.1.1	DATE 01/29/16
SCALE AS NOTED	CADD FILE
DESIGNED BY SMB	DWG PATH
CHECKED BY JP	DRAWN BY RW

FIGURE

2-1



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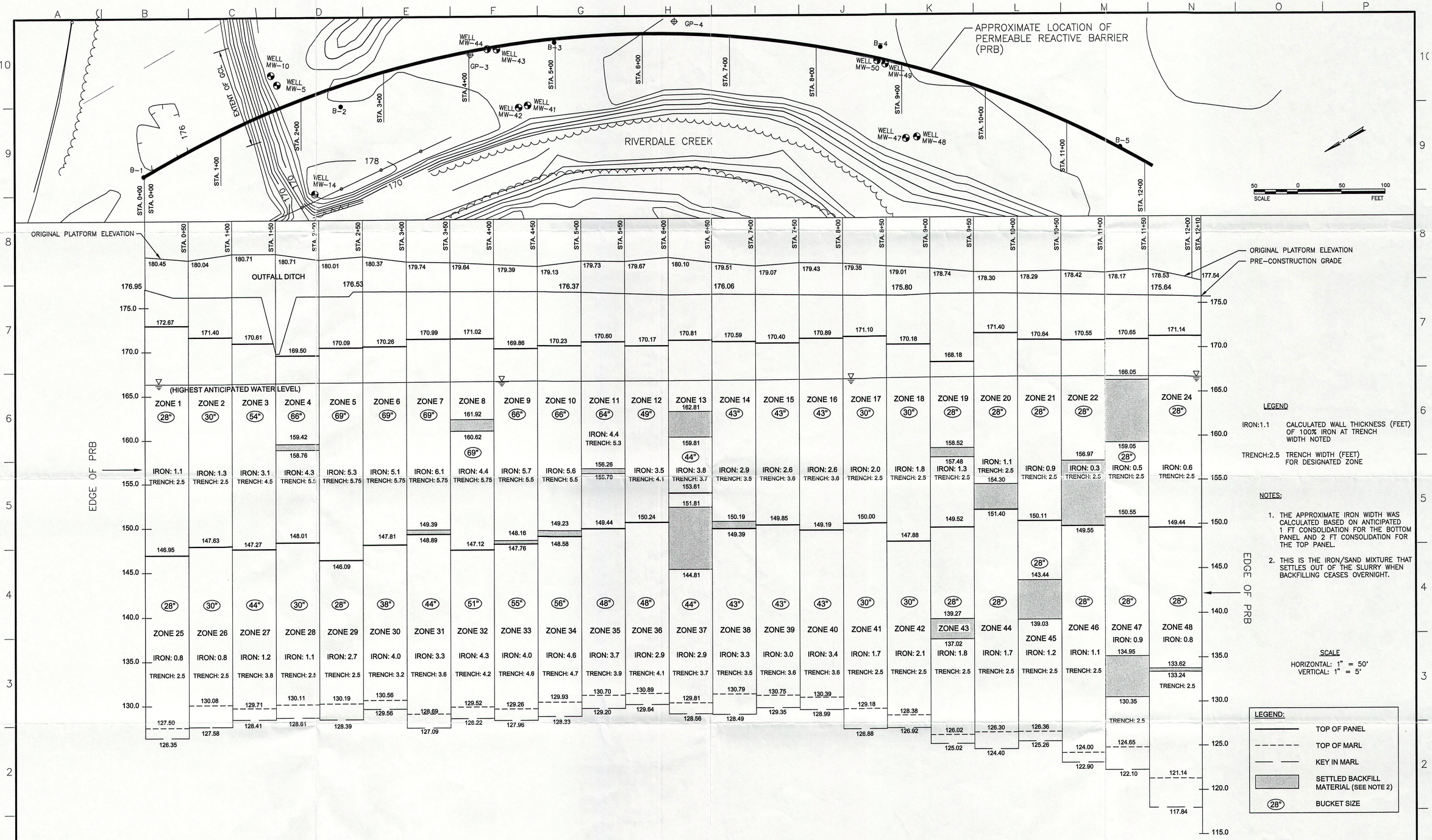
PRB WELL REJUVENTATION LOCATION MAP

FEBRUARY 2016

GRENADA MANUFACTURING, LLC PLANT

DATE	3/07/2016
SCALE	1"=100'
DRAWN BY	LP
CHECKED BY	JP
FIGURE	2-2



BROWN AND CALDWELL

SUBMITTED: _____ PROJECT MANAGER DATE: _____
APPROVED: _____ BROWN AND CALDWELL DATE: _____
APPROVED: _____ DATE: _____

LINE IS 2 INCHES AT FULL SIZE (IF NOT 2"-SCALE ACCORDINGLY)

FILE 126467-02
DRAWN J THOMAS
DESIGNED J HOW
CHECKED _____
CHECKED W RAINES

4/25/06
MICHAEL J. FREEHLING, P.E., P.G.
MISSISSIPPI LICENSE NO. 16101

REVISIONS					
ZONE	REV.	DESCRIPTION	BY	DATE	APP.

ARVIN MERITOR, INC.

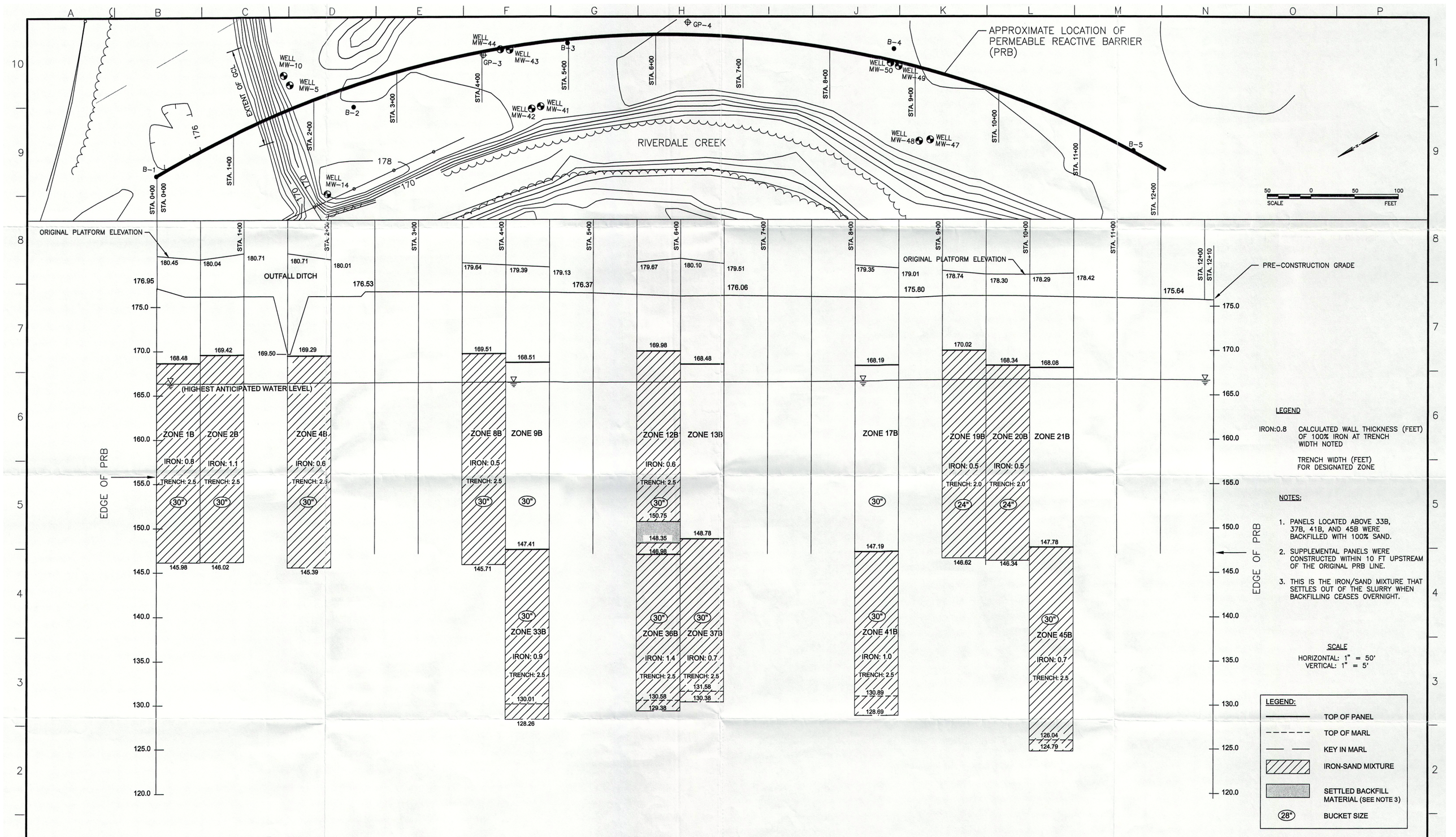
PERMEABLE REACTIVE BARRIER GROUNDWATER INTERIM MEASURE

AS-BUILT DRAWING

PERMEABLE REACTIVE BARRIER PROFILE PRIMARY BARRIER

PROJECT NUMBER **126467.002**
DRAWING NUMBER **A-1**
SHEET NUMBER **2-3**

126467-02 9/21/05 1=50



BROWN AND CALDWELL

SUBMITTED: _____ DATE: _____ PROJECT MANAGER
APPROVED: _____ DATE: _____ BROWN AND CALDWELL
APPROVED: _____ DATE: _____

LINE IS 2 INCHES AT FULL SIZE (IF NOT 2"-SCALE ACCORDINGLY)

FILE 126467-03
DRAWN J THOMAS
DESIGNED J HOW
CHECKED _____
CHECKED W RAINES

MICHAEL JON FREEHLING REGISTERED PROFESSIONAL ENGINEER
MICHAEL J. FREEHLING, P.E., P.G.
MISSISSIPPI LICENSE NO. 16101

REVISIONS					
ZONE	REV.	DESCRIPTION	BY	DATE	APP.

ARVIN MERITOR, INC.

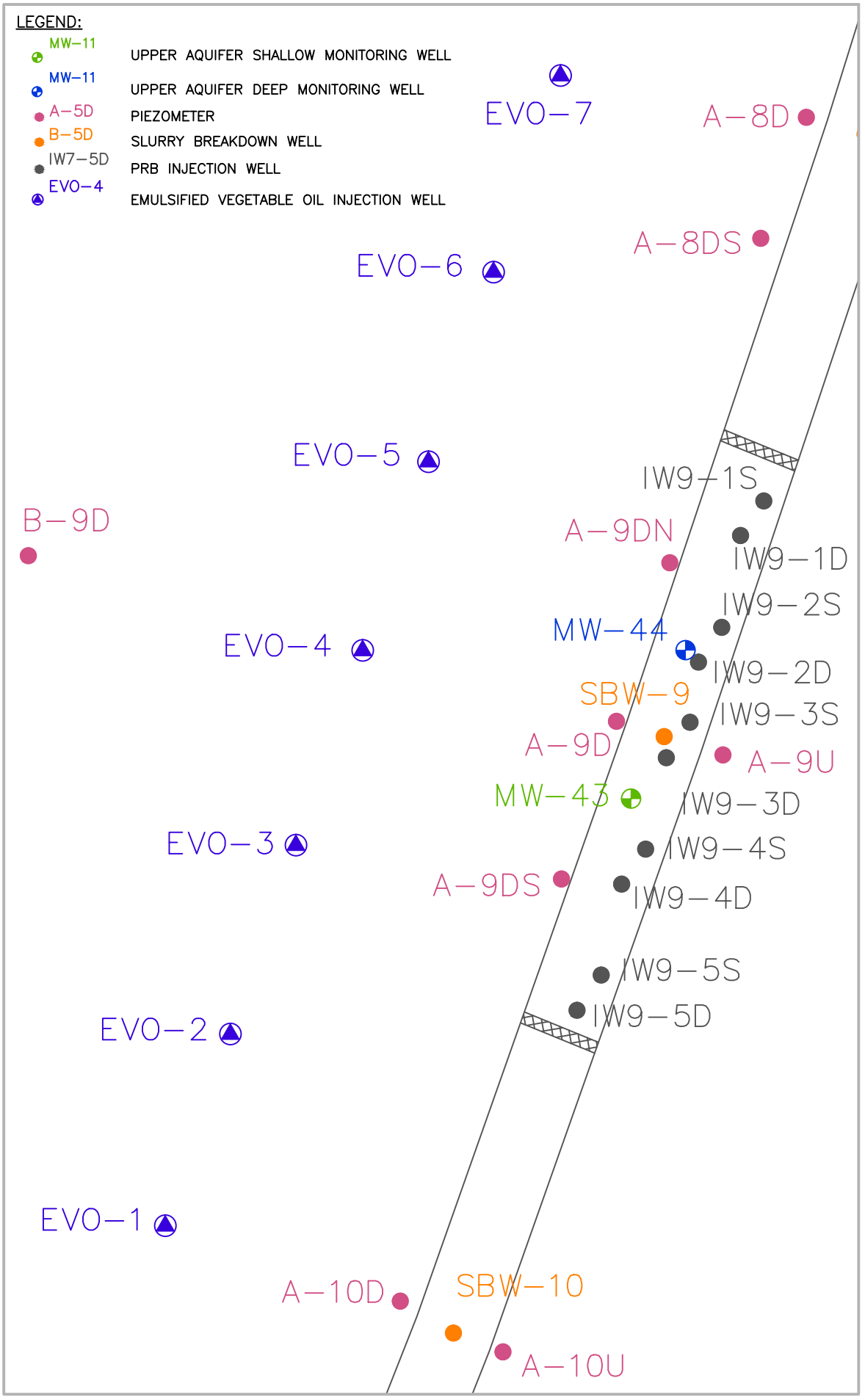
PERMEABLE REACTIVE BARRIER GROUNDWATER INTERIM MEASURE

AS-BUILT DRAWING

PERMEABLE REACTIVE BARRIER PROFILE SUPPLEMENTAL PANELS

PROJECT NUMBER 126467.002
DRAWING NUMBER A-2
SHEET NUMBER 2-4

126467-03 9/21/05 1=50



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PRB REJUVENATION PILOT TEST WELL LOCATION MAP

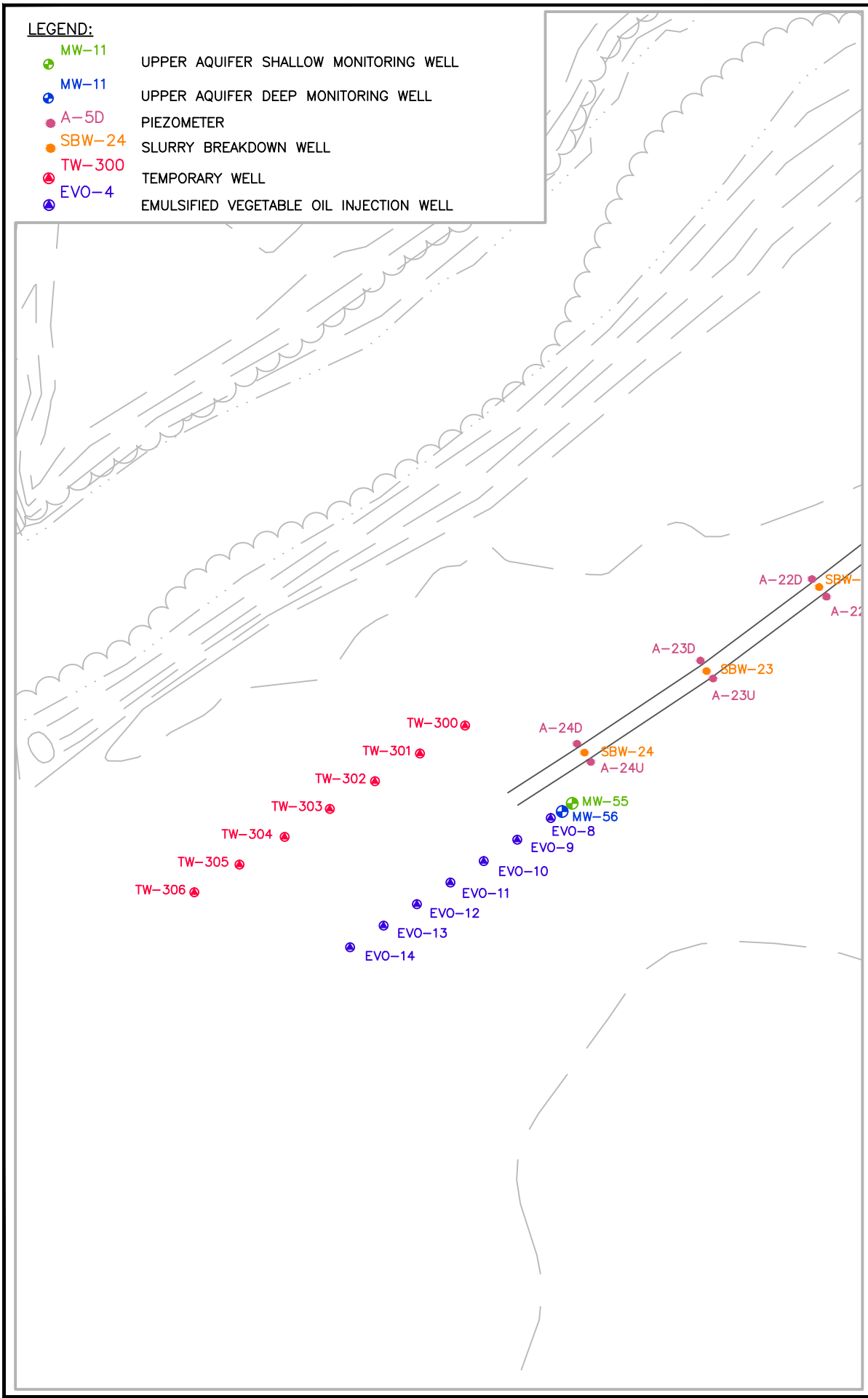
MARCH 2016

GRENADA MANUFACTURING, LLC PLANT

0 10

SCALE IN FEET

DATE	12/29/2015
SCALE	1"=10'
DRAWN BY	LP
CHECKED BY	JP
FIGURE	3-1



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PRB SOUTH END ERD PILOT TEST WELL LOCATION MAP

MARCH 2016

GRENADA MANUFACTURING, LLC PLANT

0 50

SCALE IN FEET

DATE	3/07/2016
SCALE	1"=50'
DRAWN BY	LP
CHECKED BY	JP
FIGURE	4-1

Appendix A

Monitoring Well Boring and Construction Log

BORING NO.: **IW8-2S**

AREA OF CONCERN:

Project: **Meritor PRB Pilot Study**
Location: Greneda, Mississippi (PRB Test Plot Area)
Project No.: MERT-00020
Date: 10/17/2012

Driller: Walker Hill Environmental
Drilling Method: Sonic Geoprobe
Logged by: Eric Snee
Total Depth Drilled: 30 ft bgs
Depth to Groundwater:

Depth (feet)	Monitoring Well Construction Details	PID (ppmv)	DESCRIPTION	REMARKS
0	Steel stick-up mount protective casing			
		0.0	2.5' of condensed orange brown clay with gravel	
1		0.0		
		0.0	1' of medium to fine light brown sand	
2		0.0		
	0-10' PVC Riser	0.0	**Recovery = ~3.5' - sand material likely reason for low recovery (fell out during barrel retraction)**	
3		0.0		
		0.0		
4		0.0		
		0.0		
5		0.0		
		0.0		
6		0.0		
		0.0		
7		0.0		
		0.0		
8	Bentonite to 1'	0.0		
		0.0		
9		0.0		
		0.0		
10		0.0		
	10-30'	0.0		
11	10-slot PVC screen	0.0	1.5' of brown medium to fine sand with dark black clay at bottom - not very dense (appx 6" thick)	
		0.0		
12	Iron filings and sand	0.0		
	backfill	0.0	Below clay layer is dark coarse pristine iron in rest of core	
13		0.0		
		0.0		
14		0.0	At approximately 19-20 slightly lighter/grayer material possibly from moisture	
		0.0		
15		0.0		
		0.0	**Recovery = 7' -- likey do to loss of iron during retraction of barrels**	
16		0.0		
		0.0		
17		0.0		
		0.0		
18		0.0		
		0.0		
19		0.0		
		0.0		
20		0.0		
		0.0		
21		0.0	Same pristine black iron - coarse throughout - no color change observed	
		0.0		
22		0.0		
		0.0		
23		0.0		
		0.0		
24		0.0		
		0.0		
25		0.0		
		0.0		
26		0.0		

Monitoring Well Boring and Construction Log

BORING NO.: **IW8-2S**

AREA OF CONCERN:

Project: **Meritor PRB Pilot Study**
Location: Greneda, Mississippi (PRB Test Plot Area)
Project No.: MERT-00020
Date: 10/17/2012

Driller: Walker Hill Environmental
Drilling Method: Sonic Geoprobe
Logged by: Eric Snee
Total Depth Drilled: 30 ft bgs
Depth to Groundwater:

Depth (feet)	Monitoring Well Construction Details	PID (ppmv)	DESCRIPTION	REMARKS
25				
	10-30'	0.0		
26	10-slot PVC screen	0.0		
		0.0		
27	Iron filings and sand	0.0		
	backfill	0.0		
28		0.0		
		0.0		
29		0.0		
		0.0		
30		0.0		
	End of boring @ 30'			
31				
32				
33				
34				
35				
36				
37				
38				
39				
40				
41				
42				
43				
44				
45				
46				
47				
48				
49				
50				
51				

Monitoring Well Boring and Construction Log

BORING NO.: **IW8-3S**

AREA OF CONCERN:

Project: **Meritor PRB Pilot Study**
Location: Greneda, Mississippi (PRB Test Plot Area)
Project No.: MERT-00020
Date: 10/17/2012

Driller: Walker Hill Environmental
Drilling Method: Sonic Geoprobe
Logged by: Eric Snee
Total Depth Drilled: 30 ft bgs
Depth to Groundwater:

Depth (feet)	Monitoring Well Construction Details	PID (ppmv)	DESCRIPTION	REMARKS
0	Steel stick-up mount protective casing			
		0.0	2' of fill material - orange brown silty clay with gravel	
1		0.0		
		0.0	2' of medium to fine sand backfilled on top of PRB -	
2		0.0	orange brown to light brown coloring - appeared to be	
	0-10' PVC Riser	0.0	on top of PRB	
3		0.0		
		0.0	**Recovery = ~4' - sand material likely reason for**	
4		0.0	**low recovery (fell out during barrel retraction)**	
		0.0		
5		0.0		
		0.0		
6		0.0		
		0.0		
7		0.0		
		0.0		
8	Bentonite to 1'	0.0		
		0.0		
9		0.0		
		0.0		
10		0.0		
	10-30'	0.0		
11	10-slot PVC screen	0.0	last 4' of core began iron from PRB - coarse black	
		0.0	grains with iron odor. Start of PRB delineated by	
12	Iron filings and sand	0.0	sharp contact with lighter colored sand and a layer of	
	backfill	0.0	geotextile fabric at 16'.	
13		0.0		
		0.0	Iron appeared to be pristine condition - some clay	
14		0.0	chunks towards top but not very dense	
		0.0		
15		0.0	**Recovery = 6' -- likey do to loss of iron during**	
		0.0	**retraction of barrels**	
16		0.0		
		0.0		
17		0.0		
		0.0		
18		0.0		
		0.0		
19		0.0		
		0.0		
20		0.0		
		0.0		
21		0.0	Iron from PRB throughout - top foot apppears to be	
		0.0	finer grained black mud (sluff?)	
22		0.0		
		0.0	Note - there was no observed cementation or biofilm -	
23		0.0	all grains were loose and granular, jet black (slightly	
		0.0	off black at bottom) with minimal gravel and no	
24		0.0	cobbles	
		0.0		
25		0.0	**Recovery = 8'**	
		0.0		
26		0.0		

Monitoring Well Boring and Construction Log

BORING NO.: **IW8-3S**

AREA OF CONCERN:

Project: **Meritor PRB Pilot Study**
Location: Greneda, Mississippi (PRB Test Plot Area)
Project No.: MERT-00020
Date: 10/17/2012

Driller: Walker Hill Environmental
Drilling Method: Sonic Geoprobe
Logged by: Eric Snee
Total Depth Drilled: 30 ft bgs
Depth to Groundwater:

Depth (feet)	Monitoring Well Construction Details	PID (ppmv)	DESCRIPTION	REMARKS
25				
	10-30'	0.0		
26	10-slot PVC screen	0.0		
		0.0		
27	Iron filings and sand	0.0		
	backfill	0.0		
28		0.0		
		0.0		
29		0.0		
		0.0		
30		0.0		
	End of boring @ 30'			
31				
32				
33				
34				
35				
36				
37				
38				
39				
40				
41				
42				
43				
44				
45				
46				
47				
48				
49				
50				
51				

Monitoring Well Boring and Construction Log

BORING NO.: **IW8-4S**

AREA OF CONCERN:

Project: **Meritor PRB Pilot Study**
Location: Greneda, Mississippi (PRB Test Plot Area)
Project No.: MERT-00020
Date: 10/18/2012

Driller: Walker Hill Environmental
Drilling Method: Sonic Geoprobe
Logged by: Eric Snee
Total Depth Drilled: 30 ft bgs
Depth to Groundwater:

Depth (feet)	Monitoring Well Construction Details	PID (ppmv)	DESCRIPTION	REMARKS
0	Steel stick-up mount protective casing			
		0.0	3' of compacted fill - orange brown clayey silt with gravel	
1		0.0		
	bentonite to 8'	0.0		
2		0.0	1' of medium to fine orange sand	
	0-10' PVC Riser	0.0		
3		0.0	**Recovery = ~4' - sand material likely reason for low recovery (fell out during barrel retraction)**	
		0.0		
4		0.0		
		0.0		
5		0.0		
		0.0		
6		0.0		
		0.0		
7		0.0		
		0.0		
8	Bentonite to 1'	0.0		
		0.0		
9		0.0		
		0.0		
10		0.0		
	10-30'	0.0		
11	10-slot PVC screen	0.0	1' of sluff material - sand with textile fabric at 1' - sand below textile fabric as well	
		0.0		
12	Backfilled with sand	0.0		
	due to lost iron	0.0	Iron starts at 16' - textile fabric is not at contact of sand and iron (sand between fabic and start of iron)	
13	filings during drilling	0.0		
	recovery	0.0		
14		0.0	Sand between iron and fabric is medium to fine with coarse dark gray with mixed brown (matrix is dark gray) - faint biological odor possible	
		0.0		
15		0.0		
		0.0		
16		0.0	More filter fabric located 2' within iron - possibly drag	
		0.0		
17		0.0	Top 2 feet of iron has granular material mixed in (coarse sand - not fines)	
		0.0		
18		0.0		
		0.0	**Recovery = ~6' -- likey do to loss of iron during retraction of barrels**	
19		0.0		
		0.0		
20		0.0		
		0.0		
21		0.0	Pristine iron - coarse and dark	
		0.0		
22		0.0	No signs of layering or of fines	
		0.0		
23		0.0		
		0.0		
24		0.0		
		0.0		
25		0.0	**Recovery = 3' due to driller error with bagging of core - likely was an 8-10' recovery**	
		0.0		
26		0.0		

Monitoring Well Boring and Construction Log

BORING NO.: **IW8-4S**

AREA OF CONCERN:

Project: **Meritor PRB Pilot Study**
Location: Greneda, Mississippi (PRB Test Plot Area)
Project No.: MERT-00020
Date: 10/18/2012

Driller: Walker Hill Environmental
Drilling Method: Sonic Geoprobe
Logged by: Eric Snee
Total Depth Drilled: 30 ft bgs
Depth to Groundwater:

Depth (feet)	Monitoring Well Construction Details	PID (ppmv)	DESCRIPTION	REMARKS
25				
	10-30'	0.0		
26	10-slot PVC screen	0.0		
		0.0		
27	Backfilled with sand	0.0		
	due to lost iron	0.0		
28	filings during drilling	0.0		
	recovery	0.0		
29		0.0		
		0.0		
30		0.0		
	End of boring @ 30'			
31				
32				
33				
34				
35				
36				
37				
38				
39				
40				
41				
42				
43				
44				
45				
46				
47				
48				
49				
50				
51				

WELL CONSTRUCTION DIAGRAM

SITE NAME:	Meritor, Grenada	DRILLING RIG:	Geoprobe 7822DT
		DRILL TYPE:	Direct Push
PROJECT #:	MERT-00010	START DATE:	8/25/2015
BORING ID:	IW6-1S	FINISH DATE:	8/25/2015
WELL ID:	IW6-1S	LOGGED BY:	NAH
COUNTY:	Grenada	WEATHER:	Sunny, 64-85°F
TWP:	Grenada	GROUND ELEV.:	
DRILL CO.:	EFS	NORTHING:	
DRILLER:	J. Tillman	EASTING:	

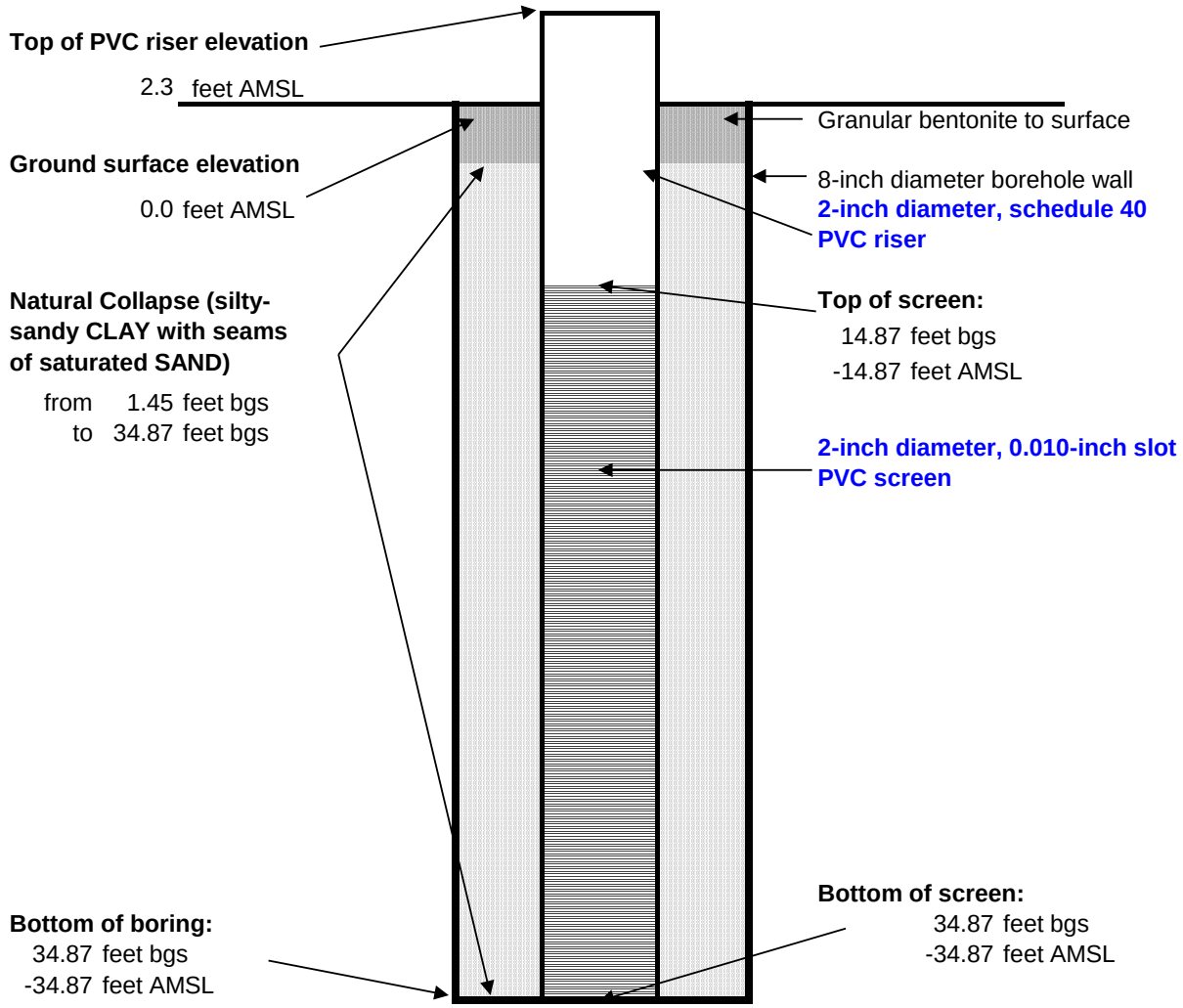
TOT DEPTH:	34.87	feet bgs
TOC ELEV.:	182.803	
SCREEN FROM:	34.87	feet bgs
SCREEN TO:	14.87	feet bgs
SCREEN TYPE:	2-inch PVC	
SCREEN SIZE:	0.020-inch slot	
CASING TYPE:	schedule 40 PVC	
CASING SIZE:	2-inch diameter	
PUMP TYPE:	N/A	

LEGEND:

Granular Bentonite

Natural Collapse

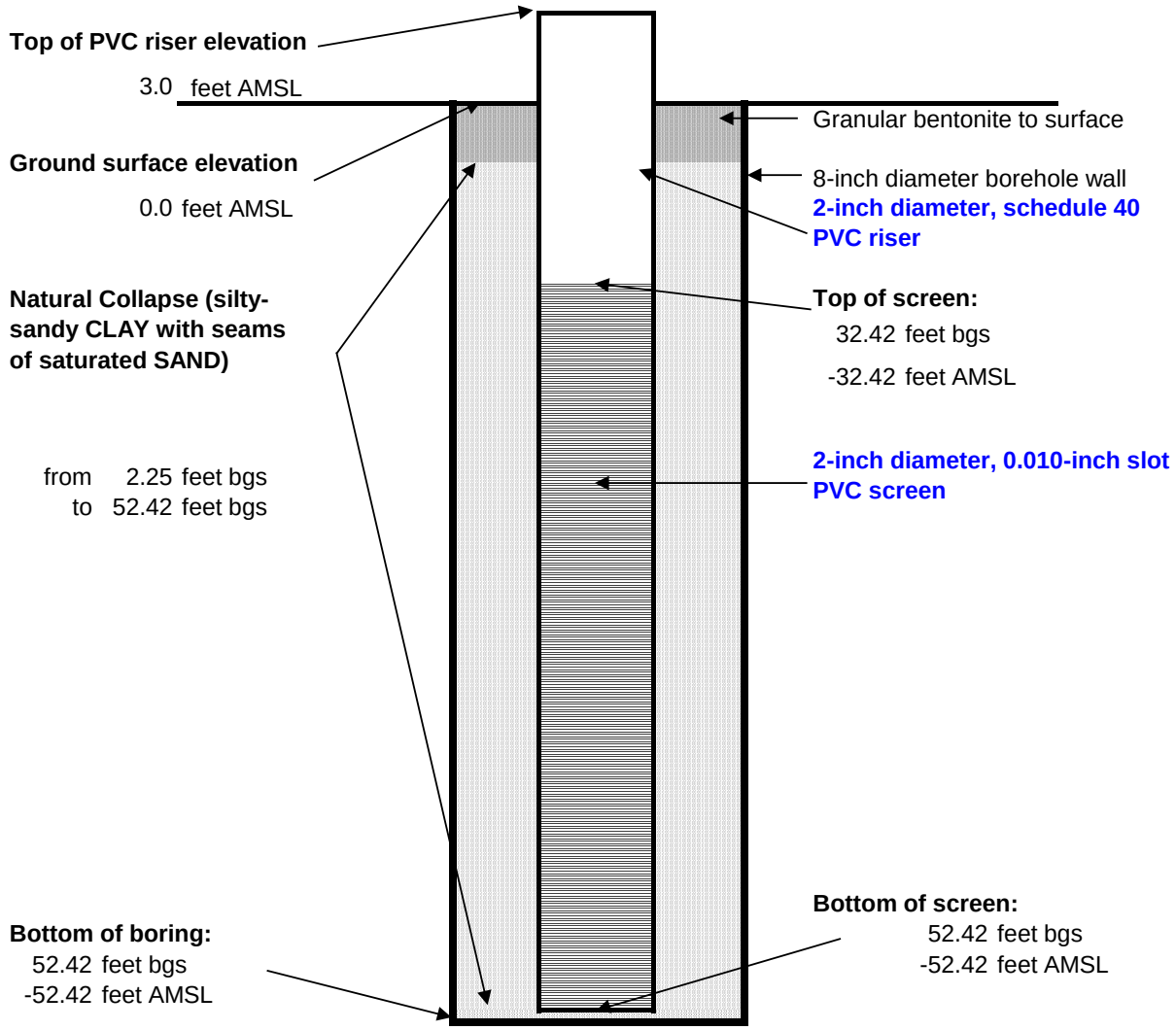
NOTES: AMSL: Above Mean Sea Level
bgs: below ground surface



WELL CONSTRUCTION DIAGRAM

SITE NAME:	Meritor, Grenada	DRILLING RIG:	Geoprobe 7822DT
		DRILL TYPE:	Direct Push
PROJECT #:	MERT-00010	START DATE:	8/25/2015
BORING ID:	IW6-1D	FINISH DATE:	8/25/2015
WELL ID:	IW6-1D	LOGGED BY:	NAH
COUNTY:	Grenada	WEATHER:	Sunny, 64-85°F
TWP:	Grenada	GROUND ELEV.:	
DRILL CO.:	EFS	NORTHING:	
DRILLER:	J. Tillman	EASTING:	

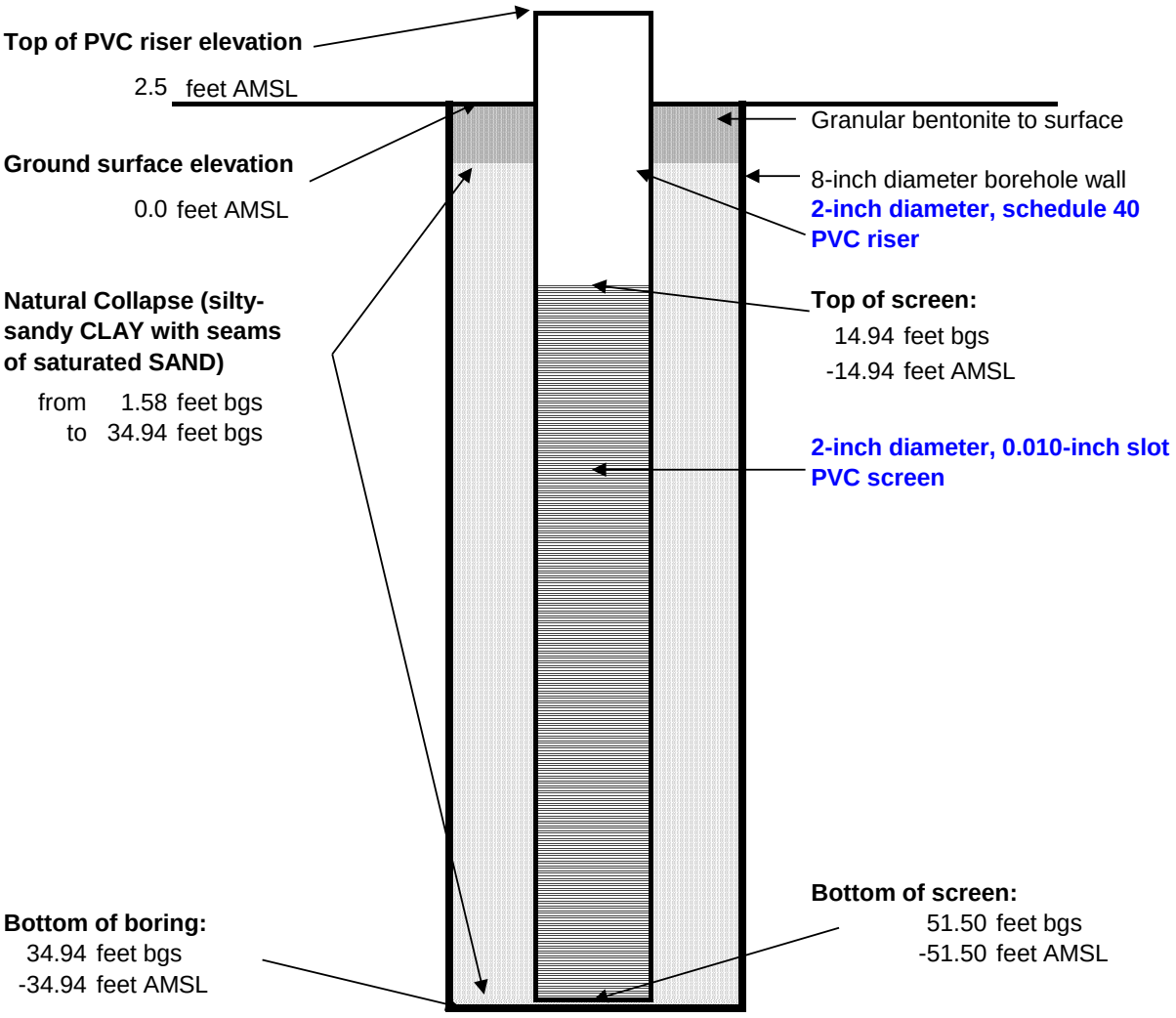
TOT DEPTH:	52.42	feet bgs	**LEGEND:**	
TOC ELEV.:	183.503		Granular Bentonite	
SCREEN FROM:	52.42	feet bgs	Natural Collapse	
SCREEN TO:	32.42	feet bgs		
SCREEN TYPE:	2-inch PVC			
SCREEN SIZE:	0.020-inch slot		**NOTES:** AMSL: Above Mean Sea Level	
CASING TYPE:	schedule 40 PVC		bgs: below ground surface	
CASING SIZE:	2-inch diameter			
PUMP TYPE:	N/A			



WELL CONSTRUCTION DIAGRAM

SITE NAME:	Meritor, Grenada	DRILLING RIG:	Geoprobe 7822DT
		DRILL TYPE:	Direct Push
PROJECT #:	MERT-00010	START DATE:	8/25/2015
BORING ID:	IW6-2S	FINISH DATE:	8/25/2015
WELL ID:	IW6-2S	LOGGED BY:	NAH
COUNTY:	Grenada	WEATHER:	Sunny, 64-85°F
TWP:	Grenada	GROUND ELEV.:	
DRILL CO.:	EFS	NORTHING:	
DRILLER:	J. Tillman	EASTING:	

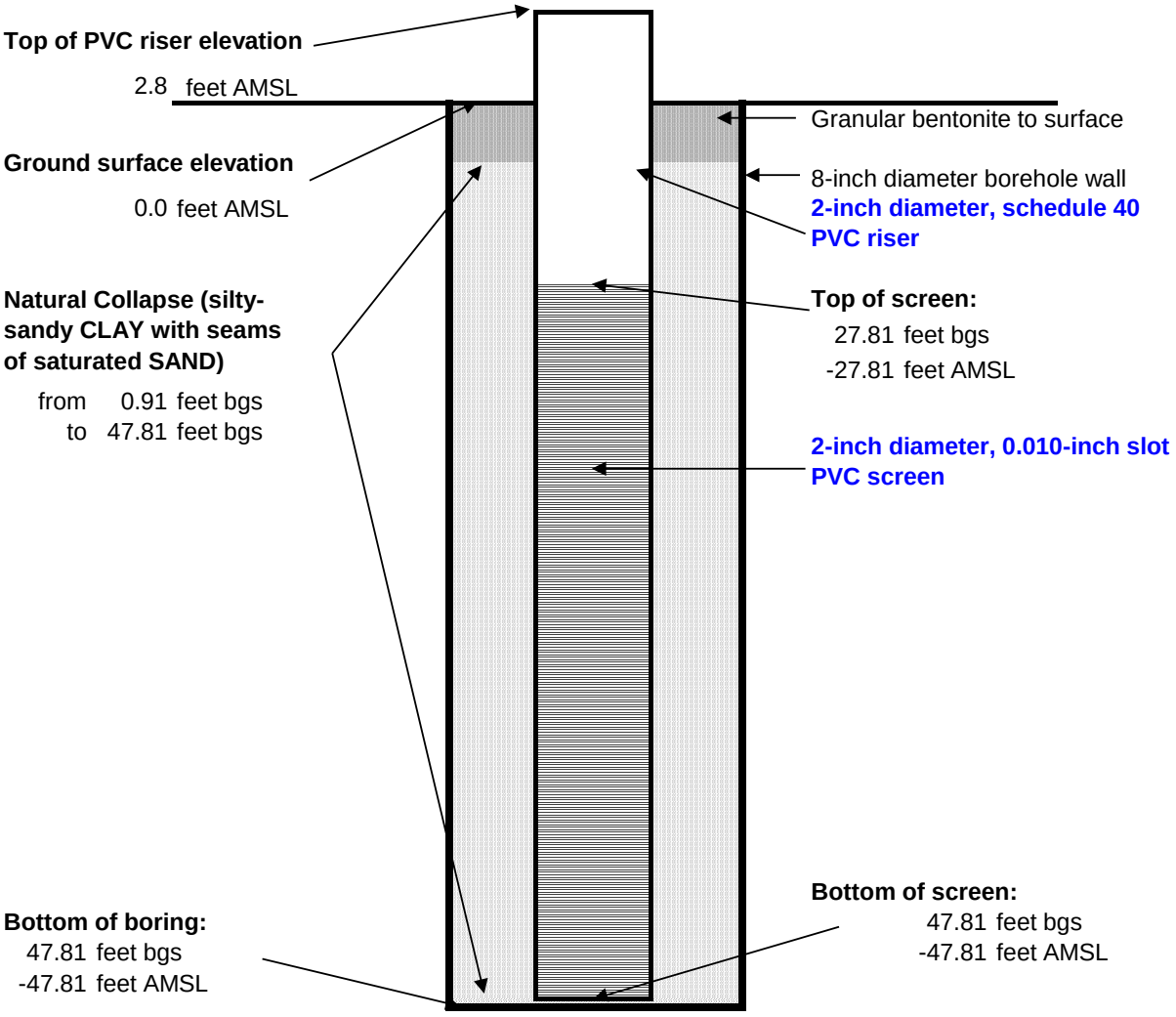
TOT DEPTH:	34.94	feet bgs	**LEGEND:**	
TOC ELEV.:	183.231		Granular Bentonite	
SCREEN FROM:	34.94	feet bgs	Natural Collapse	
SCREEN TO:	14.94	feet bgs		
SCREEN TYPE:	2-inch PVC			
SCREEN SIZE:	0.020-inch slot		**NOTES:** AMSL: Above Mean Sea Level	
CASING TYPE:	schedule 40 PVC		bgs: below ground surface	
CASING SIZE:	2-inch diameter			
PUMP TYPE:	N/A			



WELL CONSTRUCTION DIAGRAM

SITE NAME:	Meritor, Grenada	DRILLING RIG:	Geoprobe 7822DT
		DRILL TYPE:	Direct Push
PROJECT #:	MERT-00010	START DATE:	8/25/2015
BORING ID:	IW6-2D	FINISH DATE:	8/25/2015
WELL ID:	IW6-2D	LOGGED BY:	NAH
COUNTY:	Grenada	WEATHER:	Sunny, 64-85°F
TWP:	Grenada	GROUND ELEV.:	
DRILL CO.:	EFS	NORTHING:	
DRILLER:	J. Tillman	EASTING:	

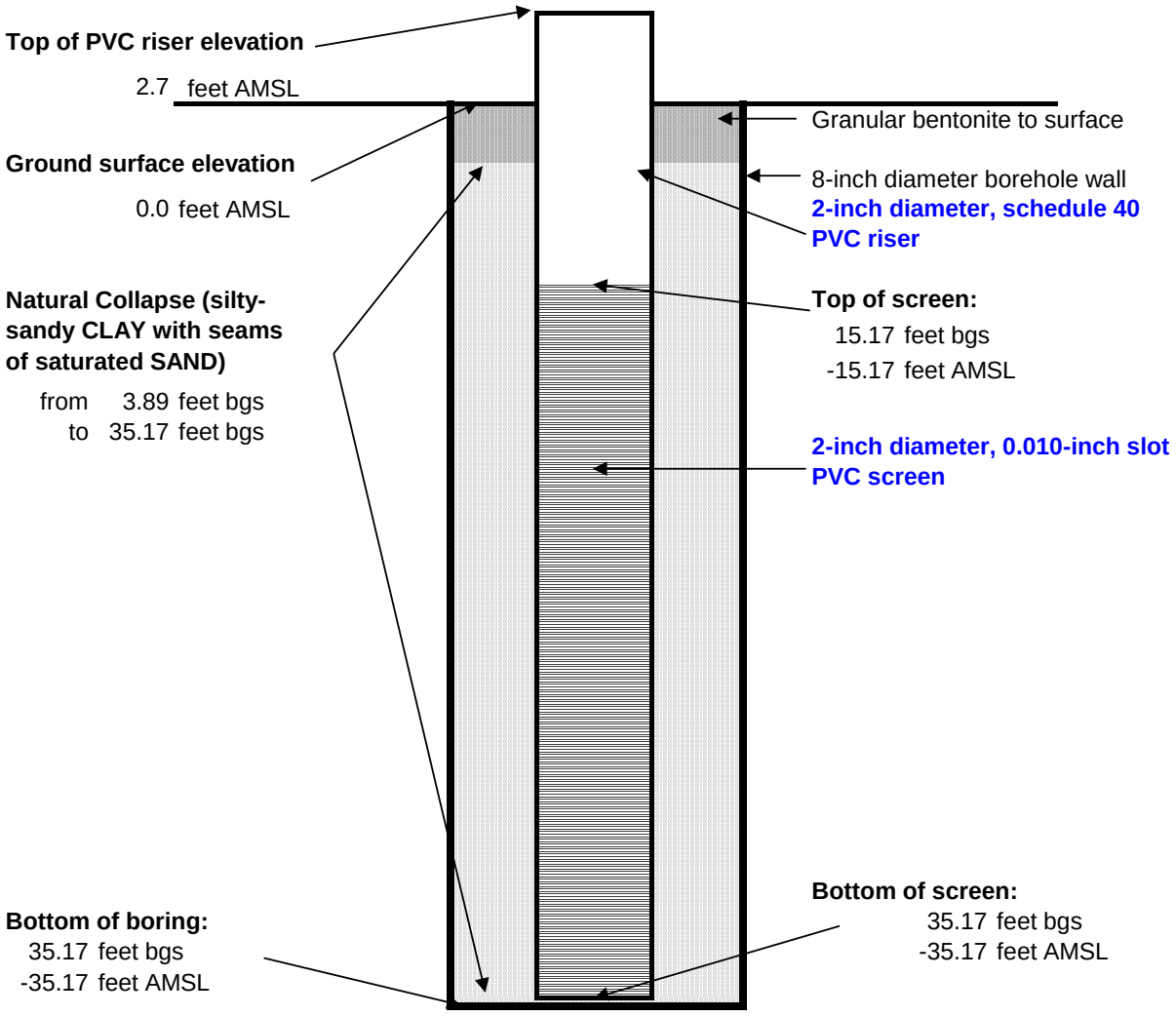
TOT DEPTH:	47.81	feet bgs	**LEGEND:**	
TOC ELEV.:	183.580		Granular Bentonite	
SCREEN FROM:	47.81	feet bgs	Natural Collapse	
SCREEN TO:	27.81	feet bgs		
SCREEN TYPE:	2-inch PVC			
SCREEN SIZE:	0.020-inch slot		**NOTES:** AMSL: Above Mean Sea Level	
CASING TYPE:	schedule 40 PVC		bgs: below ground surface	
CASING SIZE:	2-inch diameter			
PUMP TYPE:	N/A			



WELL CONSTRUCTION DIAGRAM

SITE NAME:	Meritor, Grenada	DRILLING RIG:	Geoprobe 7822DT
		DRILL TYPE:	Direct Push
PROJECT #:	MERT-00010	START DATE:	8/25/2015
BORING ID:	IW6-3S	FINISH DATE:	8/25/2015
WELL ID:	IW6-3S	LOGGED BY:	NAH
COUNTY:	Grenada	WEATHER:	Sunny, 64-85°F
TWP:	Grenada	GROUND ELEV.:	
DRILL CO.:	EFS	NORTHING:	
DRILLER:	J. Tillman	EASTING:	

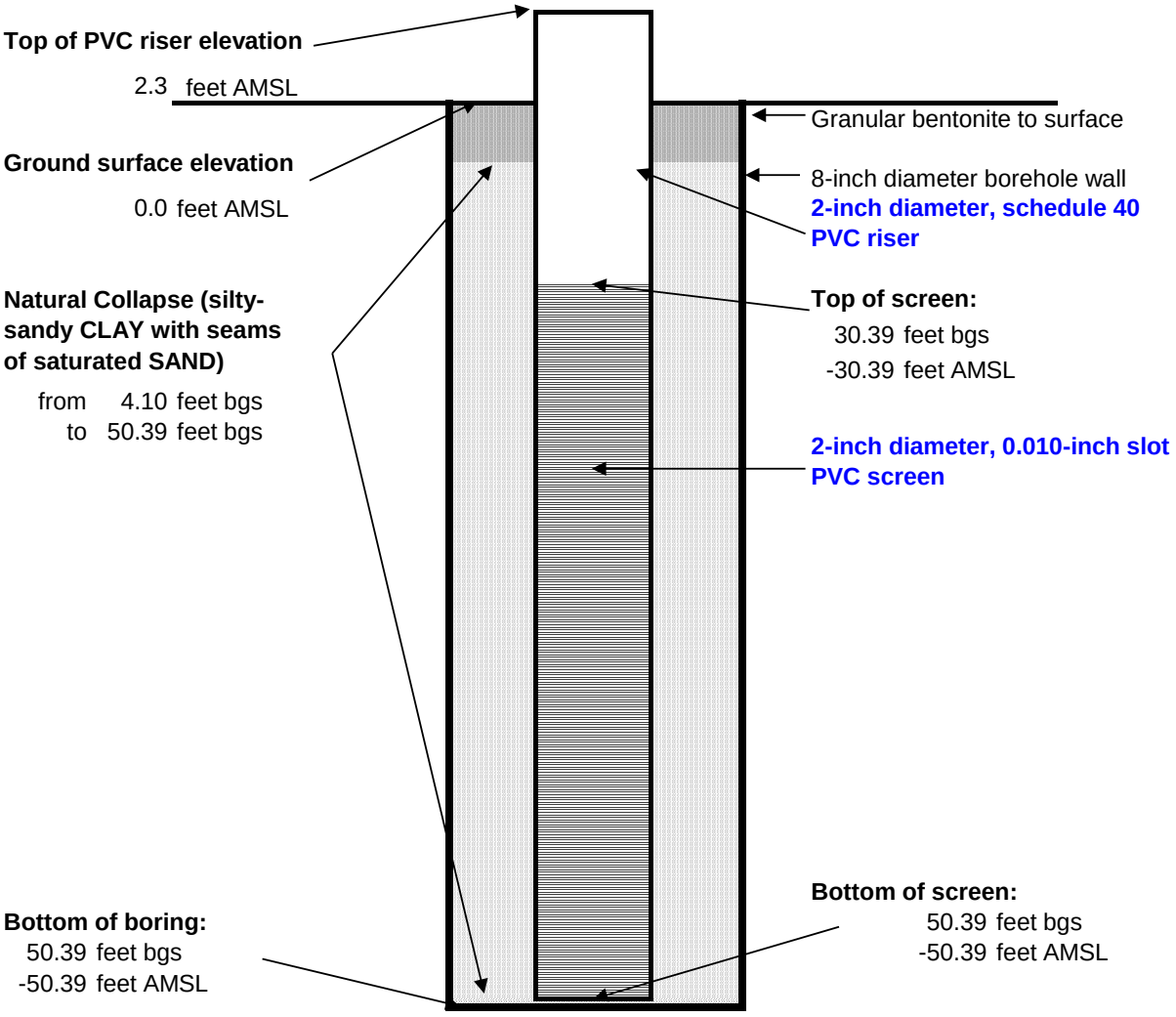
TOT DEPTH:	35.17	feet bgs	**LEGEND:**	
TOC ELEV.:	183.384		Granular Bentonite	
SCREEN FROM:	35.17	feet bgs	Natural Collapse	
SCREEN TO:	15.17	feet bgs		
SCREEN TYPE:	2-inch PVC			
SCREEN SIZE:	0.020-inch slot		**NOTES:** AMSL: Above Mean Sea Level	
CASING TYPE:	schedule 40 PVC		bgs: below ground surface	
CASING SIZE:	2-inch diameter			
PUMP TYPE:	N/A			



WELL CONSTRUCTION DIAGRAM

SITE NAME:	Meritor, Grenada	DRILLING RIG:	Geoprobe 7822DT
		DRILL TYPE:	Direct Push
PROJECT #:	MERT-00010	START DATE:	8/25/2015
BORING ID:	IW6-3D	FINISH DATE:	8/25/2015
WELL ID:	IW6-3D	LOGGED BY:	NAH
COUNTY:	Grenada	WEATHER:	Sunny, 64-85°F
TWP:	Grenada	GROUND ELEV.:	
DRILL CO.:	EFS	NORTHING:	
DRILLER:	J. Tillman	EASTING:	

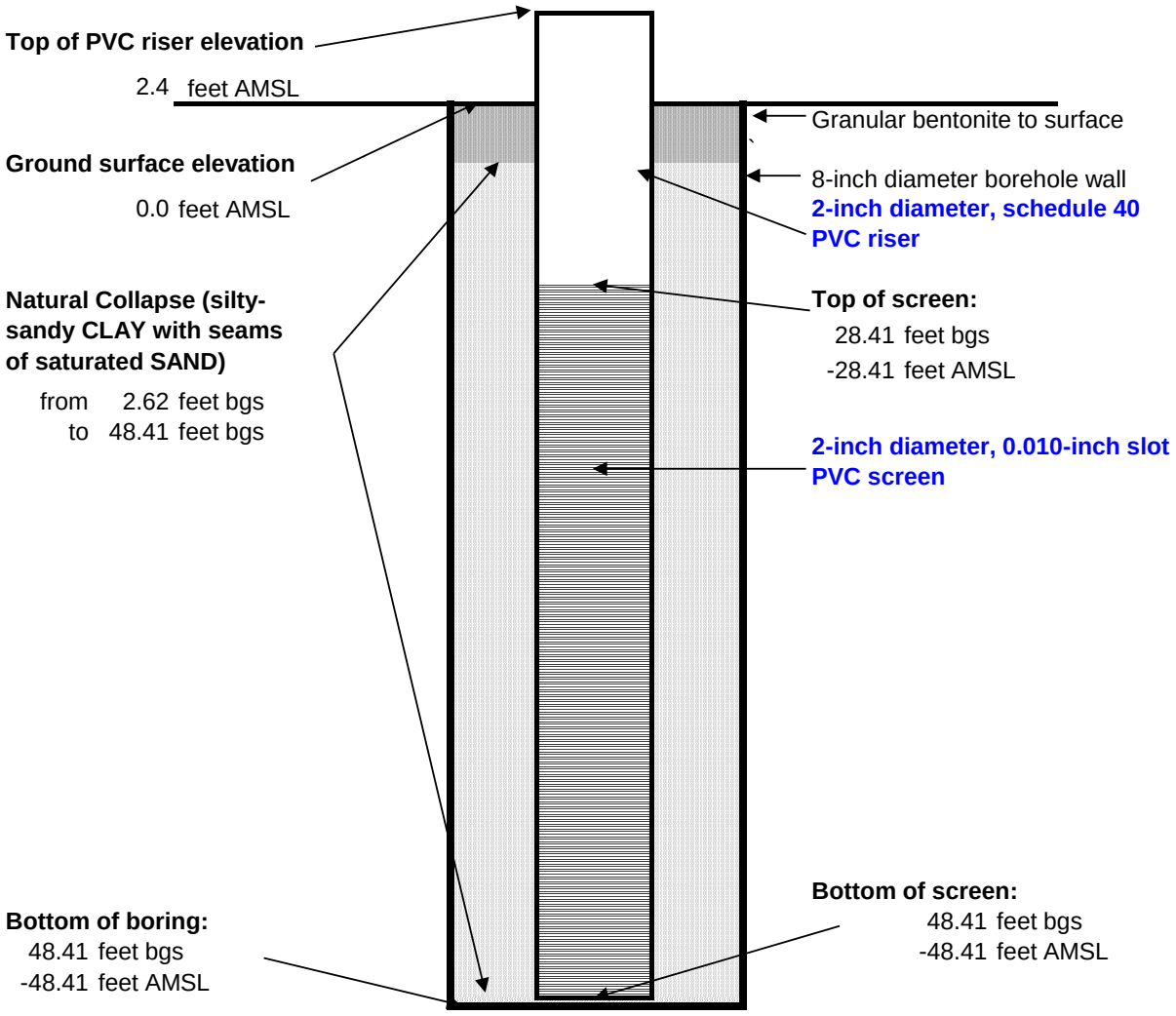
TOT DEPTH:	50.39	feet bgs	**LEGEND:**	
TOC ELEV.:	183.095		Granular Bentonite	
SCREEN FROM:	50.39	feet bgs	Natural Collapse	
SCREEN TO:	30.39	feet bgs		
SCREEN TYPE:	2-inch PVC			
SCREEN SIZE:	0.020-inch slot		**NOTES:** AMSL: Above Mean Sea Level	
CASING TYPE:	schedule 40 PVC		bgs: below ground surface	
CASING SIZE:	2-inch diameter			
PUMP TYPE:	N/A			



WELL CONSTRUCTION DIAGRAM

SITE NAME:	Meritor, Grenada	DRILLING RIG:	Geoprobe 7822DT
		DRILL TYPE:	Direct Push
PROJECT #:	MERT-00010	START DATE:	8/25/2015
BORING ID:	IW6-4D	FINISH DATE:	8/25/2015
WELL ID:	IW6-4D	LOGGED BY:	NAH
COUNTY:	Grenada	WEATHER:	Sunny, 64-85°F
TWP:	Grenada	GROUND ELEV.:	
DRILL CO.:	EFS	NORTHING:	
DRILLER:	J. Tillman	EASTING:	

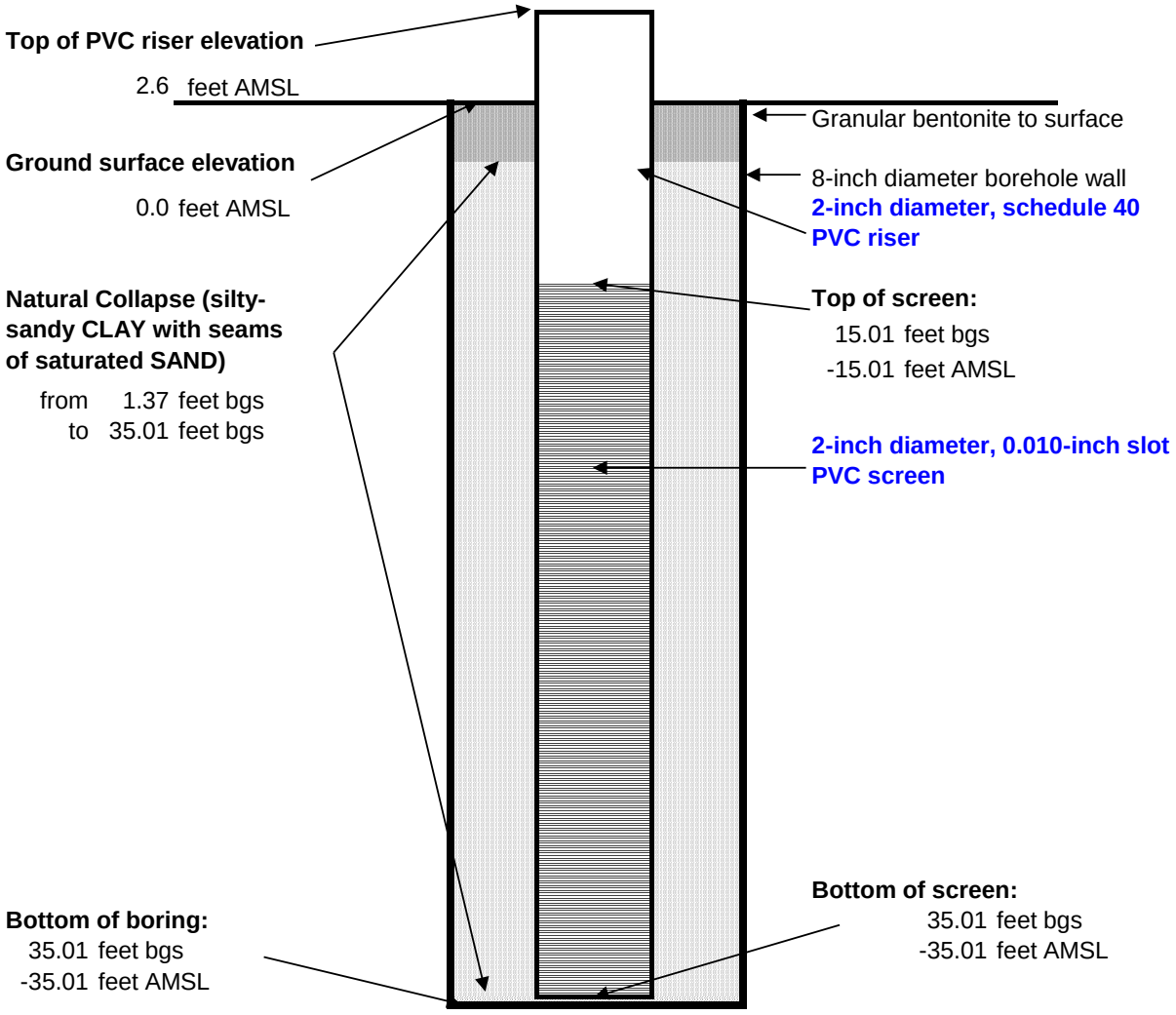
TOT DEPTH:	48.41	feet bgs	**LEGEND:**
TOC ELEV.:	183.048		Granular Bentonite
SCREEN FROM:	48.41	feet bgs	Natural Collapse
SCREEN TO:	28.41	feet bgs	
SCREEN TYPE:	2-inch PVC		
SCREEN SIZE:	0.020-inch slot		**NOTES:** AMSL: Above Mean Sea Level
CASING TYPE:	schedule 40 PVC		bgs: below ground surface
CASING SIZE:	2-inch diameter		
PUMP TYPE:	N/A		



WELL CONSTRUCTION DIAGRAM

SITE NAME:	Meritor, Grenada	DRILLING RIG:	Geoprobe 7822DT
		DRILL TYPE:	Direct Push
PROJECT #:	MERT-00010	START DATE:	8/26/2015
BORING ID:	IW6-5S	FINISH DATE:	8/26/2015
WELL ID:	IW6-5S	LOGGED BY:	NAH
COUNTY:	Grenada	WEATHER:	Sunny, 56-86°F
TWP:	Grenada	GROUND ELEV.:	
DRILL CO.:	EFS	NORTHING:	
DRILLER:	J. Tillman	EASTING:	

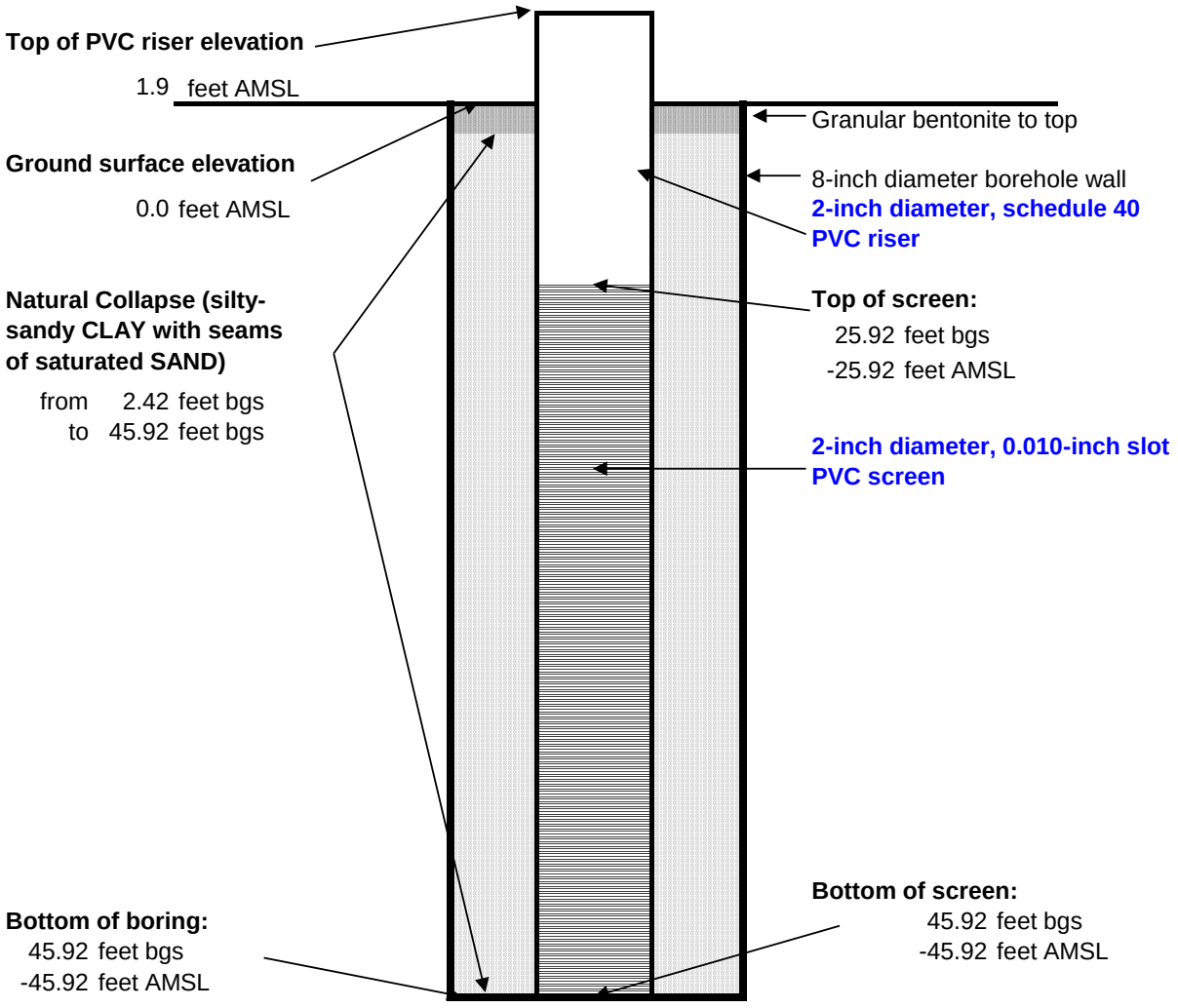
TOT DEPTH:	35.01	feet bgs	**LEGEND:**	
TOC ELEV.:	183.112		Granular Bentonite	
SCREEN FROM:	35.01	feet bgs	Natural Collapse	
SCREEN TO:	15.01	feet bgs		
SCREEN TYPE:	2-inch PVC			
SCREEN SIZE:	0.020-inch slot		**NOTES:** AMSL: Above Mean Sea Level	
CASING TYPE:	schedule 40 PVC		bgs: below ground surface	
CASING SIZE:	2-inch diameter			
PUMP TYPE:	N/A			



WELL CONSTRUCTION DIAGRAM

SITE NAME:	Meritor, Grenada	DRILLING RIG:	Geoprobe 7822DT
		DRILL TYPE:	Direct Push
PROJECT #:	MERT-00010	START DATE:	8/26/2015
BORING ID:	IW6-5D	FINISH DATE:	8/26/2015
WELL ID:	IW6-5D	LOGGED BY:	NAH
COUNTY:	Grenada	WEATHER:	Sunny, 56-86°F
TWP:	Grenada	GROUND ELEV.:	
DRILL CO.:	EFS	NORTHING:	
DRILLER:	J. Tillman	EASTING:	

TOT DEPTH:	45.92	feet bgs	**LEGEND:**
TOC ELEV.:	182.531		Granular Bentonite
SCREEN FROM:	45.92	feet bgs	Natural Collapse
SCREEN TO:	25.92	feet bgs	
SCREEN TYPE:	2-inch PVC		
SCREEN SIZE:	0.020-inch slot		**NOTES:** AMSL: Above Mean Sea Level
CASING TYPE:	schedule 40 PVC		bgs: below ground surface
CASING SIZE:	2-inch diameter		
PUMP TYPE:	N/A		



WELL CONSTRUCTION DIAGRAM

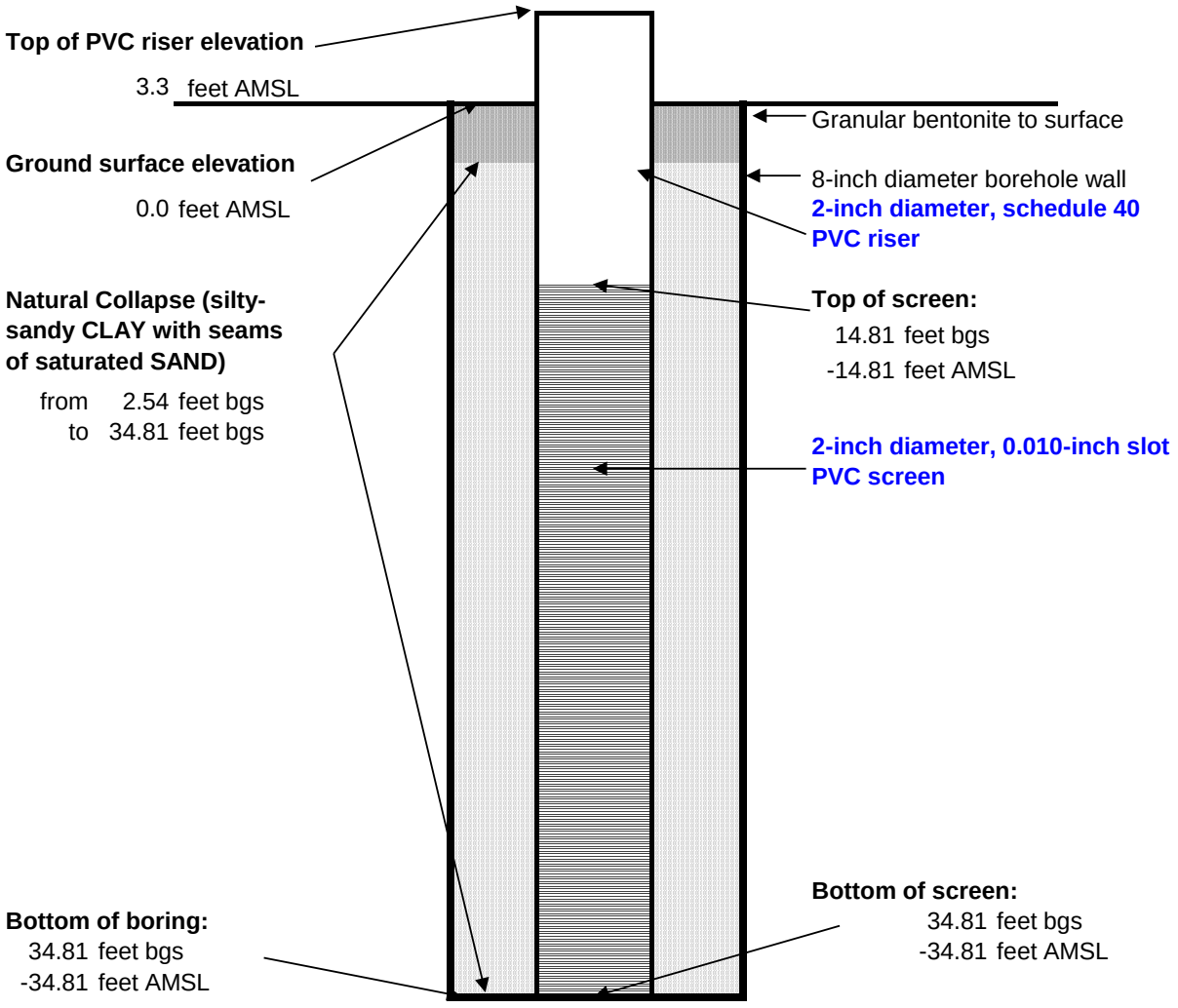
SITE NAME:	Meritor, Grenada	DRILLING RIG:	Geoprobe 7822DT
		DRILL TYPE:	Direct Push
PROJECT #:	MERT-00010	START DATE:	8/26/2015
BORING ID:	IW7-1S	FINISH DATE:	8/26/2015
WELL ID:	IW7-1S	LOGGED BY:	NAH
COUNTY:	Grenada	WEATHER:	Sunny, 56-86°F
TWP:	Grenada	GROUND ELEV.:	
DRILL CO.:	EFS	NORTHING:	
DRILLER:	J. Tillman	EASTING:	

TOT DEPTH:	34.81	feet bgs
TOC ELEV.:	183.812	
SCREEN FROM:	34.81	feet bgs
SCREEN TO:	14.81	feet bgs
SCREEN TYPE:	2-inch PVC	
SCREEN SIZE:	0.020-inch slot	
CASING TYPE:	schedule 40 PVC	
CASING SIZE:	2-inch diameter	
PUMP TYPE:	N/A	

LEGEND:

Granular Bentonite	
Natural Collapse	

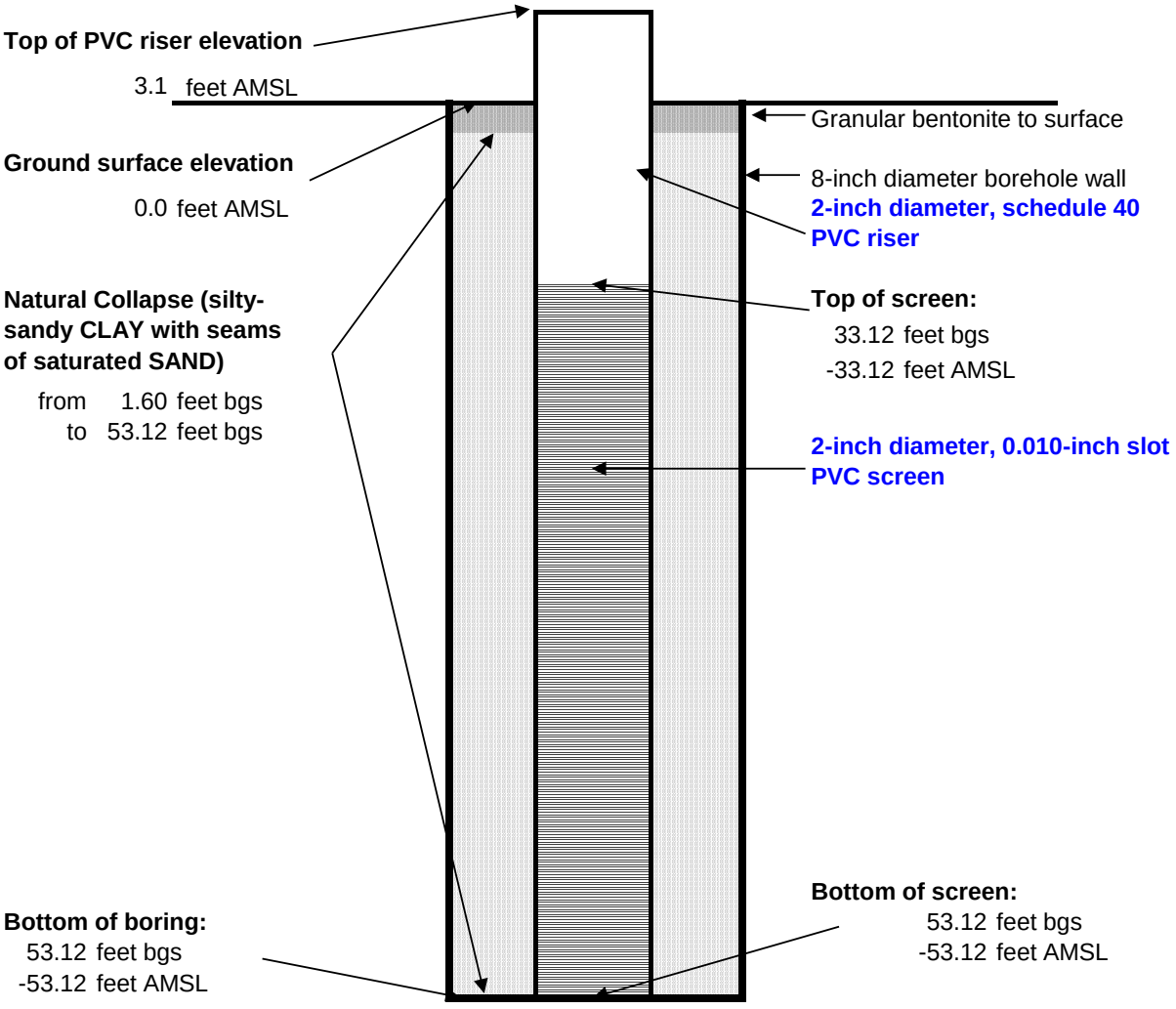
NOTES: AMSL: Above Mean Sea Level
bgs: below ground surface



WELL CONSTRUCTION DIAGRAM

SITE NAME:	Meritor, Grenada	DRILLING RIG:	Geoprobe 7822DT
		DRILL TYPE:	Direct Push
PROJECT #:	MERT-00010	START DATE:	8/26/2015
BORING ID:	IW7-1D	FINISH DATE:	8/26/2015
WELL ID:	IW7-1D	LOGGED BY:	NAH
COUNTY:	Grenada	WEATHER:	Sunny, 56-86°F
TWP:	Grenada	GROUND ELEV.:	
DRILL CO.:	EFS	NORTHING:	
DRILLER:	J. Tillman	EASTING:	

TOT DEPTH:	53.12	feet bgs	**LEGEND:**	
TOC ELEV.:	183.474		Granular bentonite	
SCREEN FROM:	53.12	feet bgs	Natural Collapse	
SCREEN TO:	33.12	feet bgs		
SCREEN TYPE:	2-inch PVC			
SCREEN SIZE:	0.020-inch slot		**NOTES:** AMSL: Above Mean Sea Level	
CASING TYPE:	schedule 40 PVC		bgs: below ground surface	
CASING SIZE:	2-inch diameter			
PUMP TYPE:	N/A			



WELL CONSTRUCTION DIAGRAM

SITE NAME:	Meritor, Grenada	DRILLING RIG:	Geoprobe 7822DT
		DRILL TYPE:	Direct Push
PROJECT #:	MERT-00010	START DATE:	8/26/2015
BORING ID:	IW7-2S	FINISH DATE:	8/26/2015
WELL ID:	IW7-2S	LOGGED BY:	NAH
COUNTY:	Grenada	WEATHER:	Sunny, 56-86°F
TWP:	Grenada	GROUND ELEV.:	
DRILL CO.:	EFS	NORTHING:	
DRILLER:	J. Tillman	EASTING:	

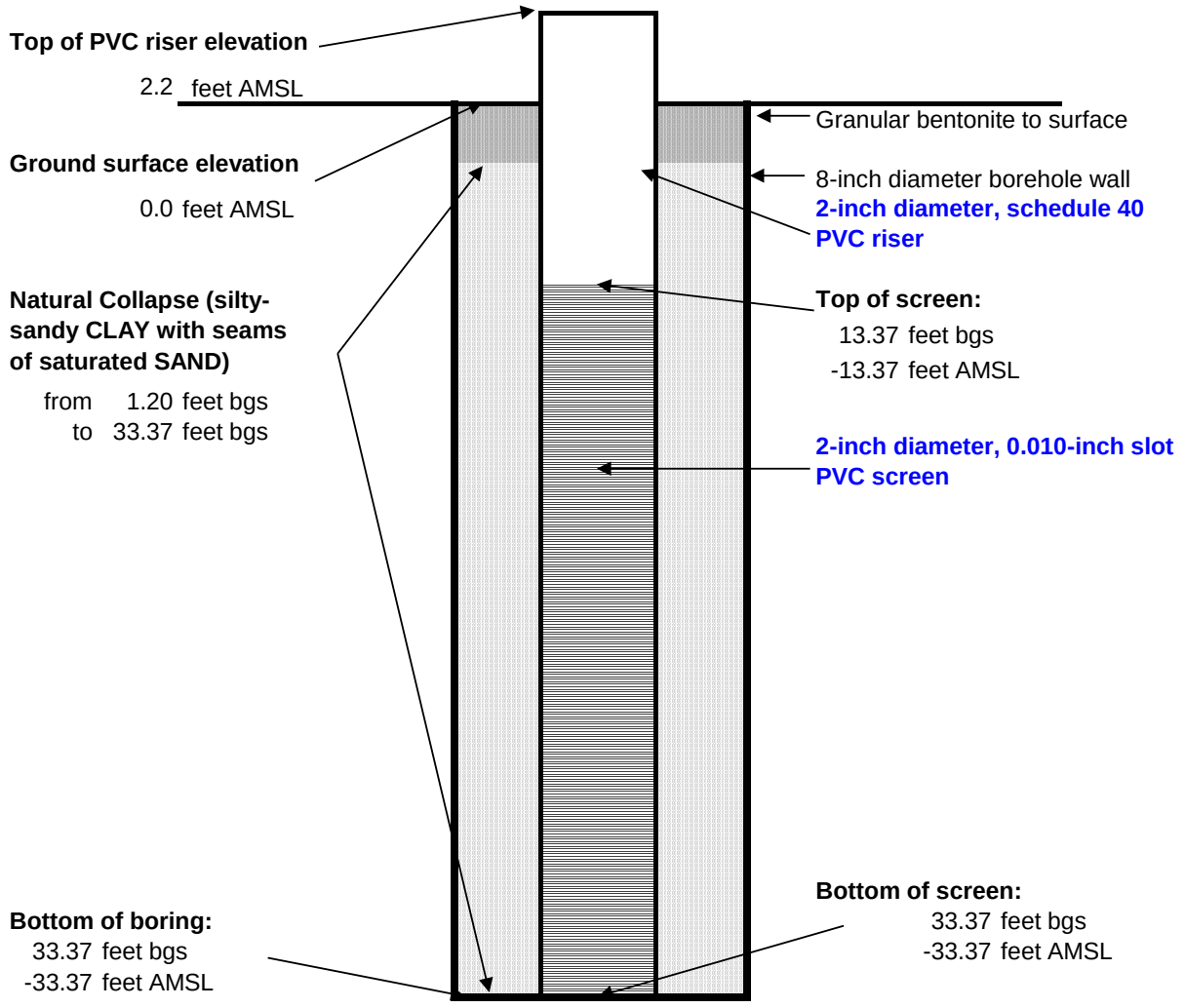
TOT DEPTH:	33.37	feet bgs
TOC ELEV.:	182.407	
SCREEN FROM:	33.37	feet bgs
SCREEN TO:	13.37	feet bgs
SCREEN TYPE:	2-inch PVC	
SCREEN SIZE:	0.020-inch slot	
CASING TYPE:	schedule 40 PVC	
CASING SIZE:	2-inch diameter	
PUMP TYPE:	N/A	

LEGEND:

Granular bentonite

Natural Collapse

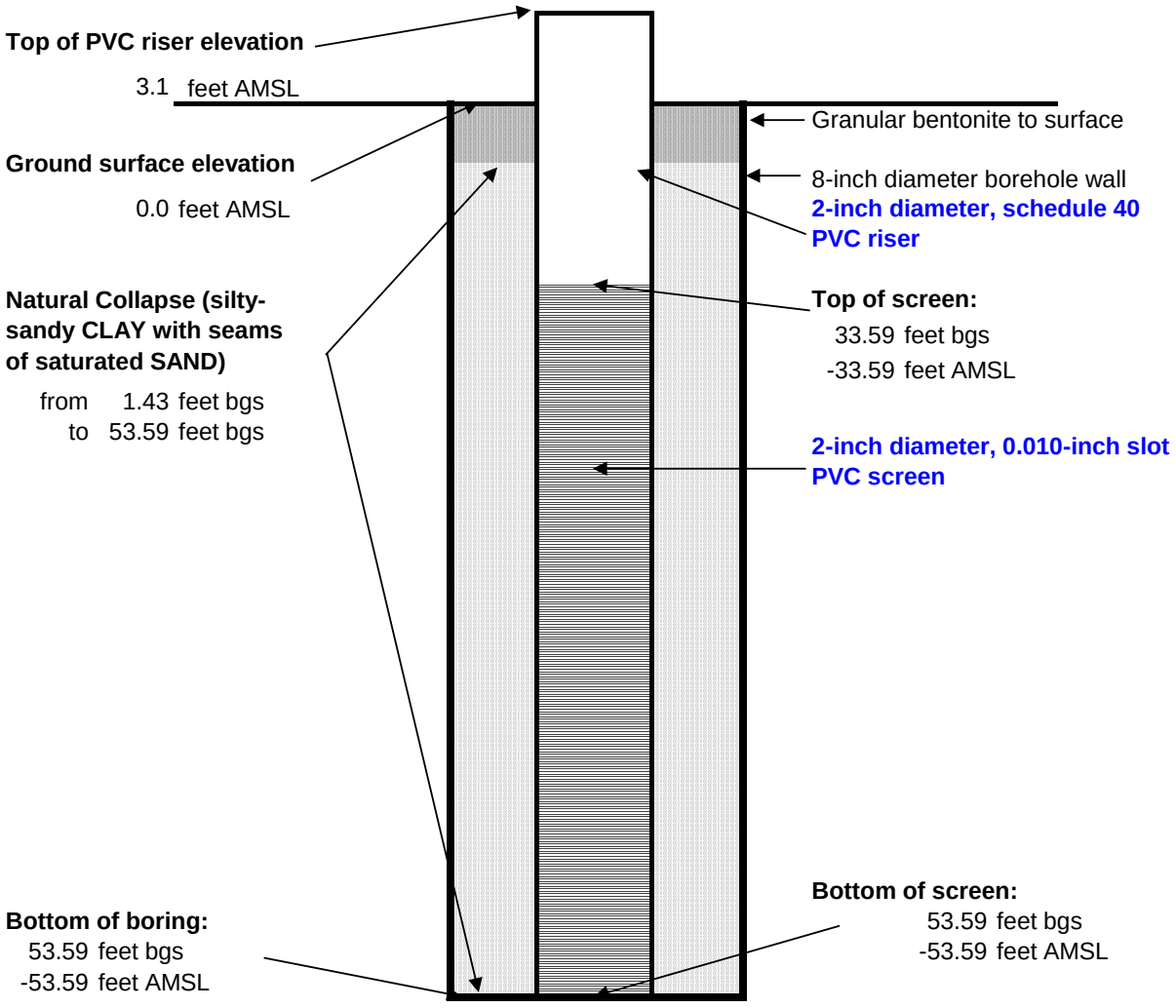
NOTES: AMSL: Above Mean Sea Level
bgs: below ground surface



WELL CONSTRUCTION DIAGRAM

SITE NAME:	Meritor, Grenada	DRILLING RIG:	Geoprobe 7822DT
		DRILL TYPE:	Direct Push
PROJECT #:	MERT-00010	START DATE:	8/26/2015
BORING ID:	IW7-2D	FINISH DATE:	8/26/2015
WELL ID:	IW7-2D	LOGGED BY:	NAH
COUNTY:	Grenada	WEATHER:	Sunny, 56-86°F
TWP:	Grenada	GROUND ELEV.:	
DRILL CO.:	EFS	NORTHING:	
DRILLER:	J. Tillman	EASTING:	

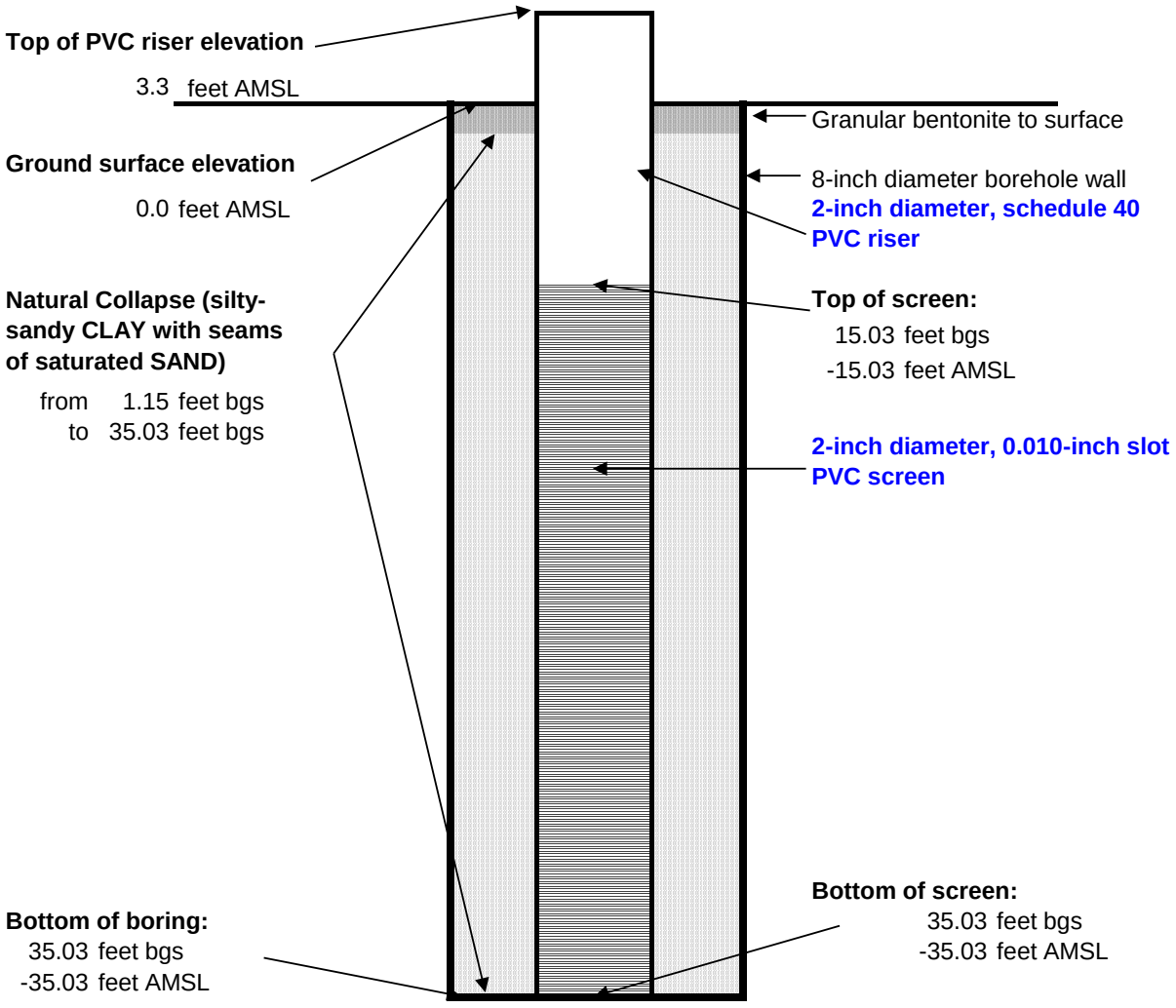
TOT DEPTH:	53.59	feet bgs	**LEGEND:**	
TOC ELEV.:	183.246		Granular Bentonite	
SCREEN FROM:	53.59	feet bgs	Natural Collapse	
SCREEN TO:	33.59	feet bgs		
SCREEN TYPE:	2-inch PVC			
SCREEN SIZE:	0.020-inch slot		**NOTES:** AMSL: Above Mean Sea Level	
CASING TYPE:	schedule 40 PVC		bgs: below ground surface	
CASING SIZE:	2-inch diameter			
PUMP TYPE:	N/A			



WELL CONSTRUCTION DIAGRAM

SITE NAME:	Meritor, Grenada	DRILLING RIG:	Geoprobe 7822DT
		DRILL TYPE:	Direct Push
PROJECT #:	MERT-00010	START DATE:	8/26/2015
BORING ID:	IW7-3S	FINISH DATE:	8/26/2015
WELL ID:	IW7-3S	LOGGED BY:	NAH
COUNTY:	Grenada	WEATHER:	Sunny, 56-86°F
TWP:	Grenada	GROUND ELEV.:	
DRILL CO.:	EFS	NORTHING:	
DRILLER:	J. Tillman	EASTING:	

TOT DEPTH:	35.03	feet bgs	**LEGEND:**	
TOC ELEV.:	183.378		Granular bentonite	
SCREEN FROM:	35.03	feet bgs	Natural Collapse	
SCREEN TO:	15.03	feet bgs		
SCREEN TYPE:	2-inch PVC			
SCREEN SIZE:	0.020-inch slot		**NOTES:** AMSL: Above Mean Sea Level	
CASING TYPE:	schedule 40 PVC		bgs: below ground surface	
CASING SIZE:	2-inch diameter			
PUMP TYPE:	N/A			



WELL CONSTRUCTION DIAGRAM

SITE NAME:	Meritor, Grenada	DRILLING RIG:	Geoprobe 7822DT
		DRILL TYPE:	Direct Push
PROJECT #:	MERT-00010	START DATE:	8/26/2015
BORING ID:	IW7-4S	FINISH DATE:	8/26/2015
WELL ID:	IW7-4S	LOGGED BY:	NAH
COUNTY:	Grenada	WEATHER:	Sunny, 56-86°F
TWP:	Grenada	GROUND ELEV.:	
DRILL CO.:	EFS	NORTHING:	
DRILLER:	J. Tillman	EASTING:	

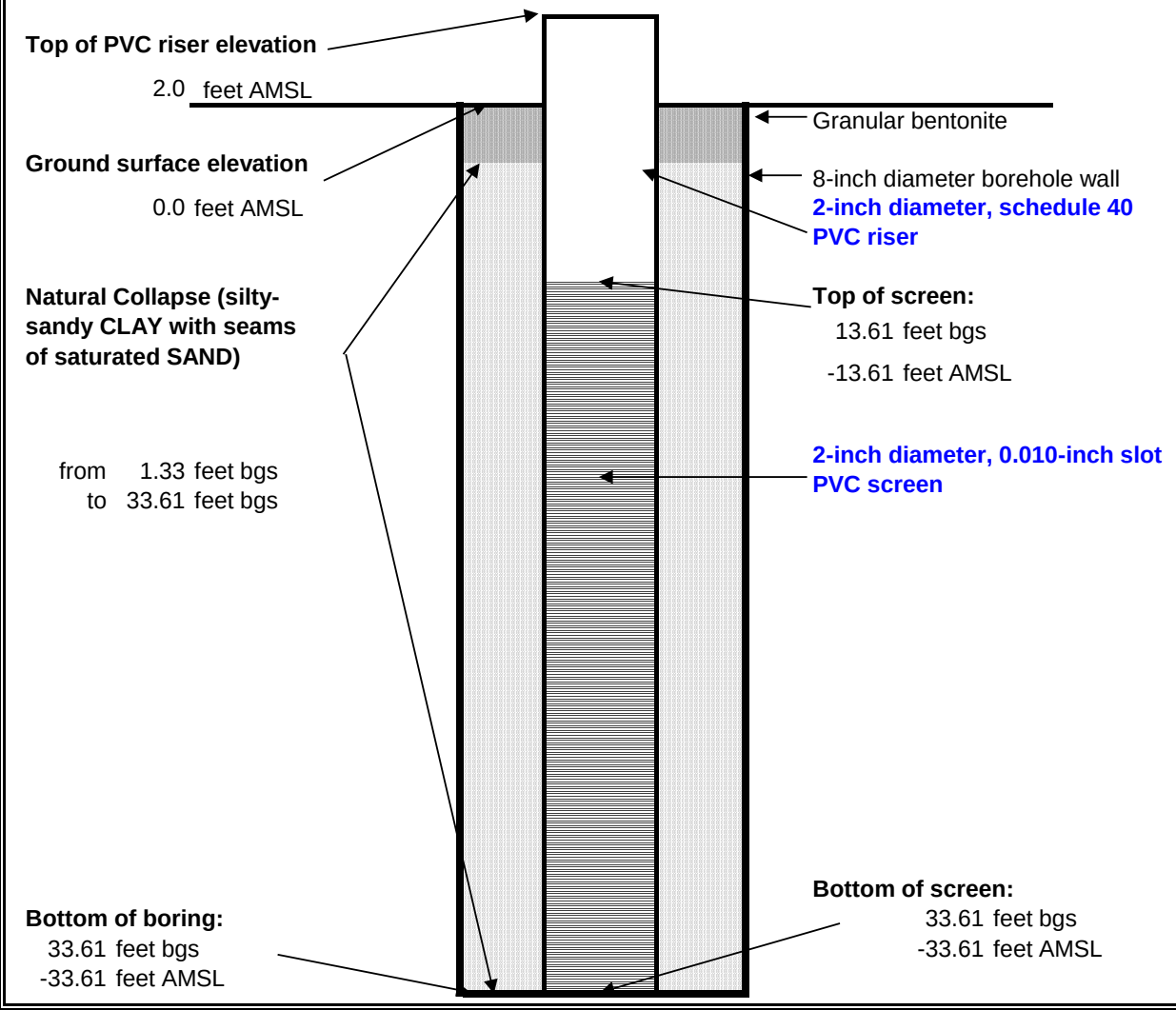
TOT DEPTH:	33.61	feet bgs
TOC ELEV.:	182.101	
SCREEN FROM:	33.61	feet bgs
SCREEN TO:	13.61	feet bgs
SCREEN TYPE:	2-inch PVC	
SCREEN SIZE:	0.020-inch slot	
CASING TYPE:	schedule 40 PVC	
CASING SIZE:	2-inch diameter	
PUMP TYPE:	N/A	

LEGEND:

Granular Bentonite

Natural Collapse

NOTES: AMSL: Above Mean Sea Level
bgs: below ground surface



WELL CONSTRUCTION DIAGRAM

SITE NAME:	Meritor, Grenada	DRILLING RIG:	Geoprobe 7822DT
		DRILL TYPE:	Direct Push
PROJECT #:	MERT-00010	START DATE:	8/26/2015
BORING ID:	IW7-4D	FINISH DATE:	8/26/2015
WELL ID:	IW7-4D	LOGGED BY:	NAH
COUNTY:	Grenada	WEATHER:	Sunny, 56-86°F
TWP:	Grenada	GROUND ELEV.:	
DRILL CO.:	EFS	NORTHING:	
DRILLER:	J. Tillman	EASTING:	

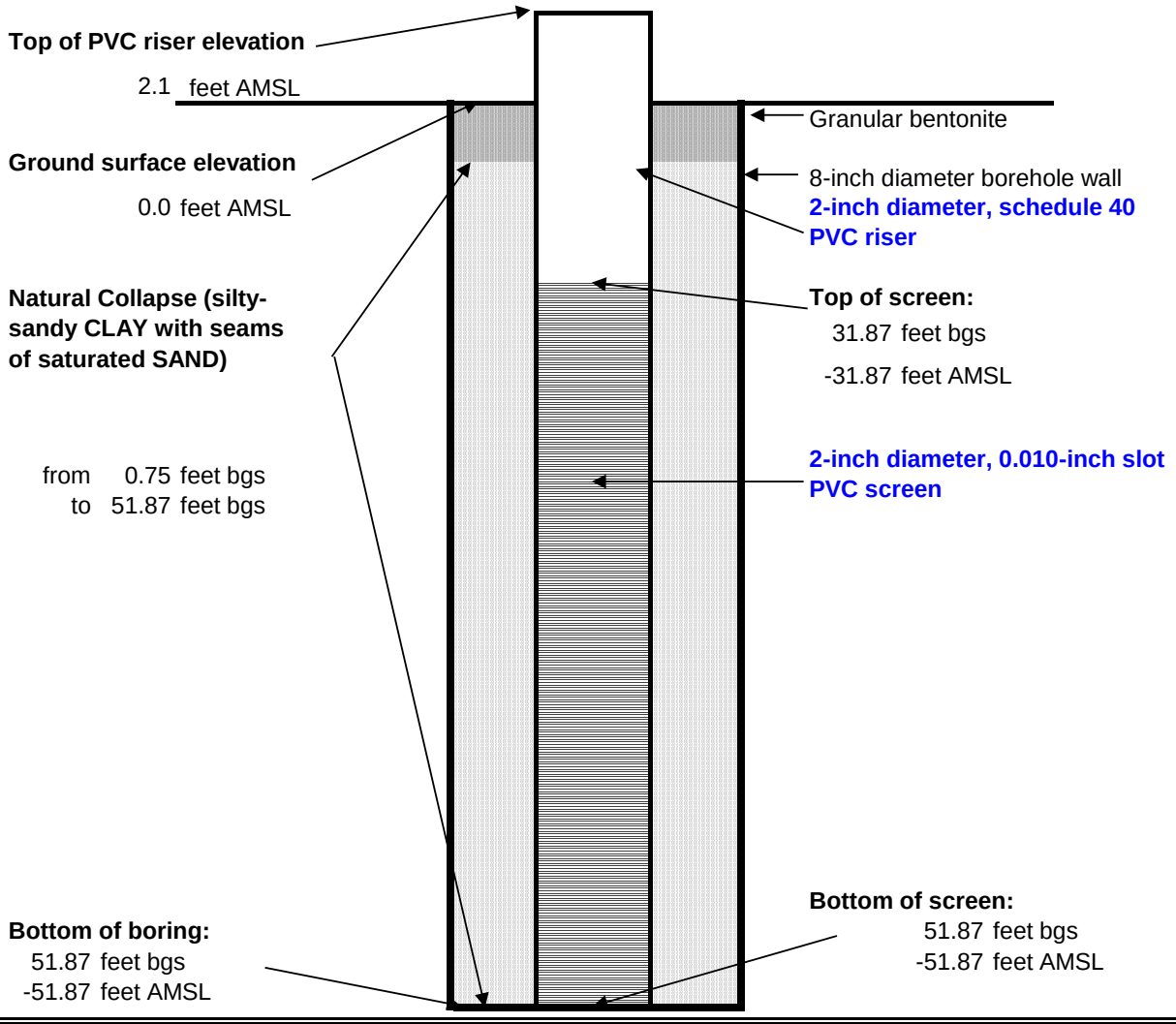
TOT DEPTH:	51.87	feet bgs
TOC ELEV.:	182.086	
SCREEN FROM:	51.87	feet bgs
SCREEN TO:	31.87	feet bgs
SCREEN TYPE:	2-inch PVC	
SCREEN SIZE:	0.020-inch slot	
CASING TYPE:	schedule 40 PVC	
CASING SIZE:	2-inch diameter	
PUMP TYPE:	N/A	

LEGEND:

Granular Bentonite

Natural Collapse

NOTES: AMSL: Above Mean Sea Level
bgs: below ground surface



WELL CONSTRUCTION DIAGRAM

SITE NAME:	Meritor, Grenada	DRILLING RIG:	Geoprobe 7822DT
		DRILL TYPE:	Direct Push
PROJECT #:	MERT-00010	START DATE:	8/27/2015
BORING ID:	IW7-5S	FINISH DATE:	8/27/2015
WELL ID:	IW7-5S	LOGGED BY:	NAH
COUNTY:	Grenada	WEATHER:	Sunny, 63-85°F
TWP:	Grenada	GROUND ELEV.:	
DRILL CO.:	EFS	NORTHING:	
DRILLER:	J. Tillman	EASTING:	

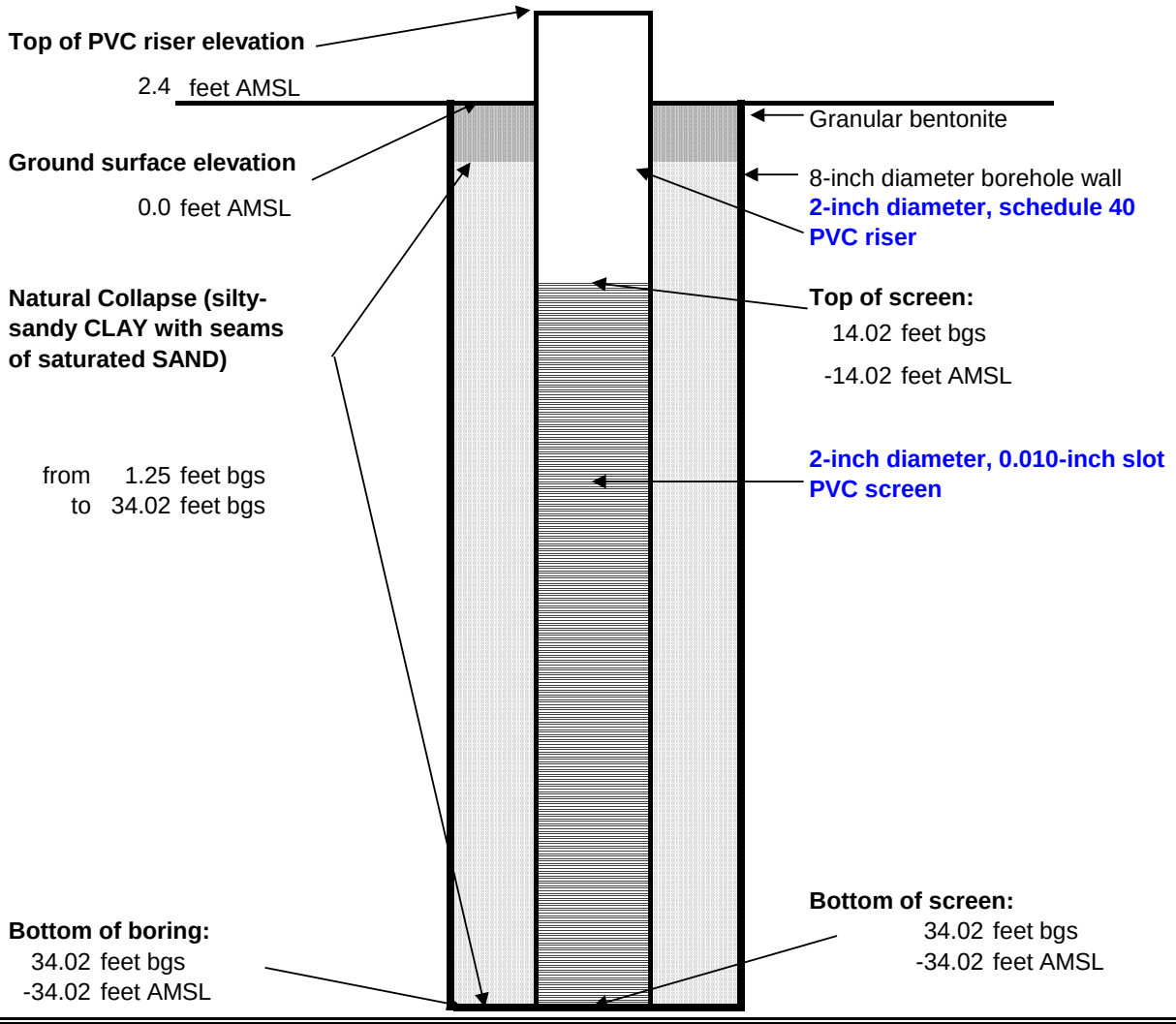
TOT DEPTH:	34.02	feet bgs
TOC ELEV.:	182.444	
SCREEN FROM:	34.02	feet bgs
SCREEN TO:	14.02	feet bgs
SCREEN TYPE:	2-inch PVC	
SCREEN SIZE:	0.020-inch slot	
CASING TYPE:	schedule 40 PVC	
CASING SIZE:	2-inch diameter	
PUMP TYPE:	N/A	

LEGEND:

Granular Bentonite

Natural Collapse

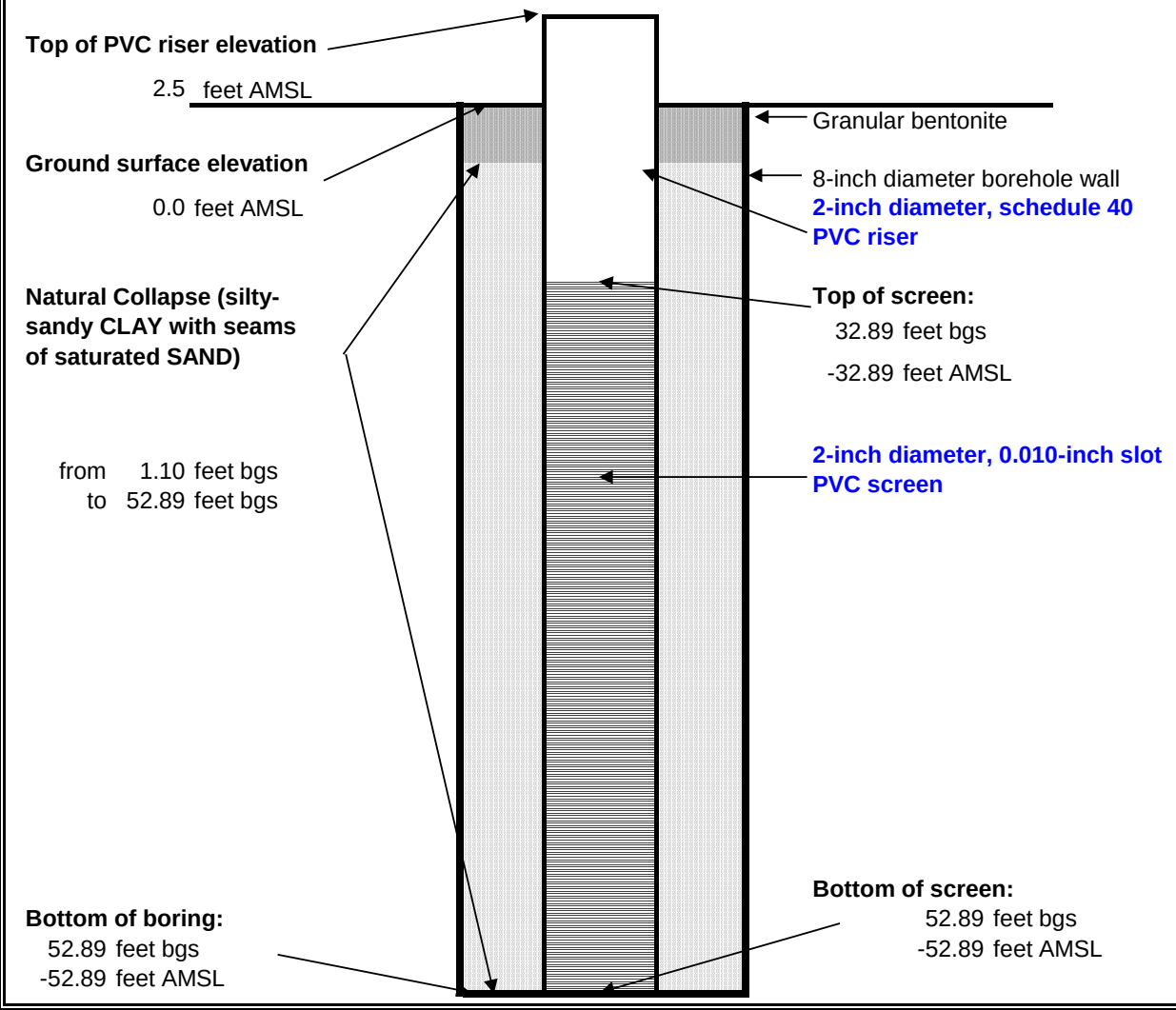
NOTES: AMSL: Above Mean Sea Level
bgs: below ground surface



WELL CONSTRUCTION DIAGRAM

SITE NAME:	Meritor, Grenada	DRILLING RIG:	Geoprobe 7822DT
		DRILL TYPE:	Direct Push
PROJECT #:	MERT-00010	START DATE:	8/27/2015
BORING ID:	IW7-5D	FINISH DATE:	8/27/2015
WELL ID:	IW7-5D	LOGGED BY:	NAH
COUNTY:	Grenada	WEATHER:	Sunny, 63-85°F
TWP:	Grenada	GROUND ELEV.:	
DRILL CO.:	EFS	NORTHING:	
DRILLER:	J. Tillman	EASTING:	

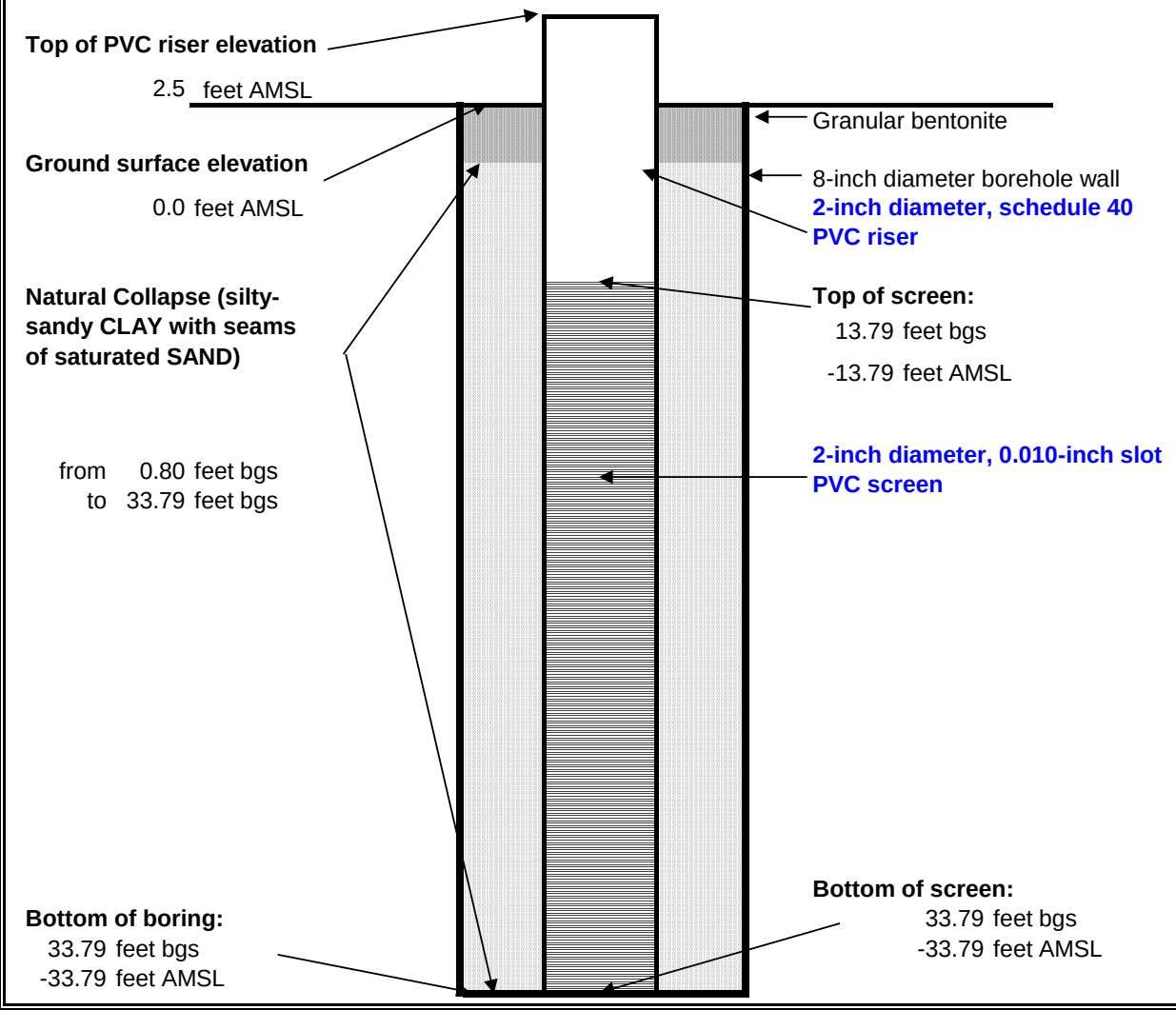
TOT DEPTH:	52.89	feet bgs	**LEGEND:**
TOC ELEV.:	182.382		Granular Bentonite
SCREEN FROM:	52.89	feet bgs	Natural Collapse
SCREEN TO:	32.89	feet bgs	
SCREEN TYPE:	2-inch PVC		
SCREEN SIZE:	0.020-inch slot		**NOTES:** AMSL: Above Mean Sea Level
CASING TYPE:	schedule 40 PVC		bgs: below ground surface
CASING SIZE:	2-inch diameter		
PUMP TYPE:	N/A		



WELL CONSTRUCTION DIAGRAM

SITE NAME:	Meritor, Grenada	DRILLING RIG:	Geoprobe 7822DT
		DRILL TYPE:	Direct Push
PROJECT #:	MERT-00010	START DATE:	8/24/2015
BORING ID:	IW8-1S	FINISH DATE:	8/24/2015
WELL ID:	IW8-1S	LOGGED BY:	NAH
COUNTY:	Grenada	WEATHER:	Sunny, 64-85°F
TWP:	Grenada	GROUND ELEV.:	
DRILL CO.:	EFS	NORTHING:	
DRILLER:	J. Tillman	EASTING:	

TOT DEPTH:	33.79	feet bgs	**LEGEND:**
TOC ELEV.:	182.309		Granular Bentonite
SCREEN FROM:	33.79	feet bgs	Natural Collapse
SCREEN TO:	13.79	feet bgs	
SCREEN TYPE:	2-inch PVC		
SCREEN SIZE:	0.020-inch slot		**NOTES:** AMSL: Above Mean Sea Level
CASING TYPE:	schedule 40 PVC		bgs: below ground surface
CASING SIZE:	2-inch diameter		
PUMP TYPE:	N/A		



WELL CONSTRUCTION DIAGRAM

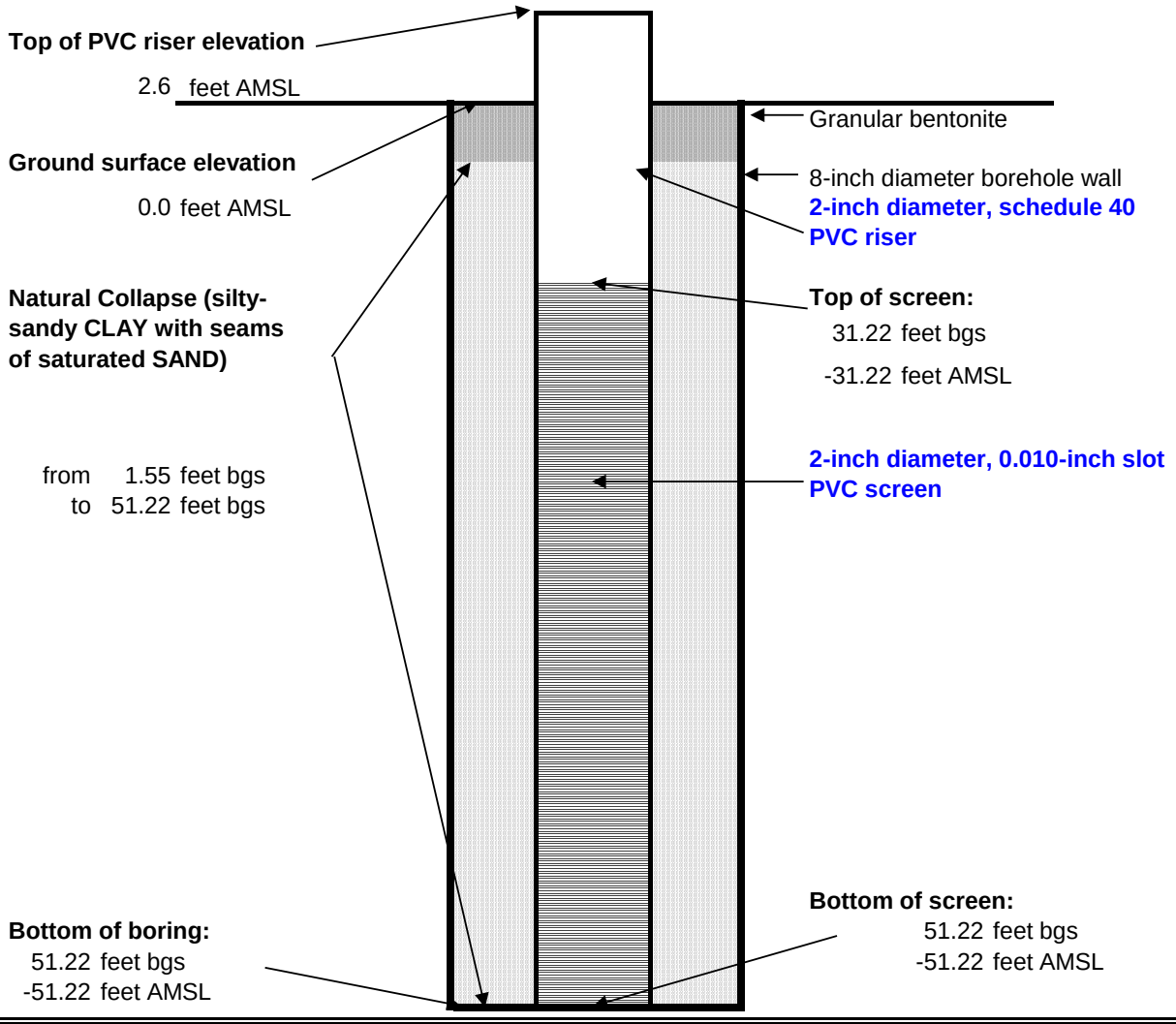
SITE NAME:	Meritor, Grenada	DRILLING RIG:	Geoprobe 7822DT
		DRILL TYPE:	Direct Push
PROJECT #:	MERT-00010	START DATE:	8/24/2015
BORING ID:	IW8-1D	FINISH DATE:	8/24/2015
WELL ID:	IW8-1D	LOGGED BY:	NAH
COUNTY:	Grenada	WEATHER:	Sunny, 64-85°F
TWP:	Grenada	GROUND ELEV.:	
DRILL CO.:	EFS	NORTHING:	
DRILLER:	J. Tillman	EASTING:	

TOT DEPTH:	51.22	feet bgs
TOC ELEV.:	182.341	
SCREEN FROM:	51.22	feet bgs
SCREEN TO:	31.22	feet bgs
SCREEN TYPE:	2-inch PVC	
SCREEN SIZE:	0.020-inch slot	
CASING TYPE:	schedule 40 PVC	
CASING SIZE:	2-inch diameter	
PUMP TYPE:	N/A	

LEGEND:

Granular Bentonite	
Natural Collapse	

NOTES: AMSL: Above Mean Sea Level
bgs: below ground surface



WELL CONSTRUCTION DIAGRAM

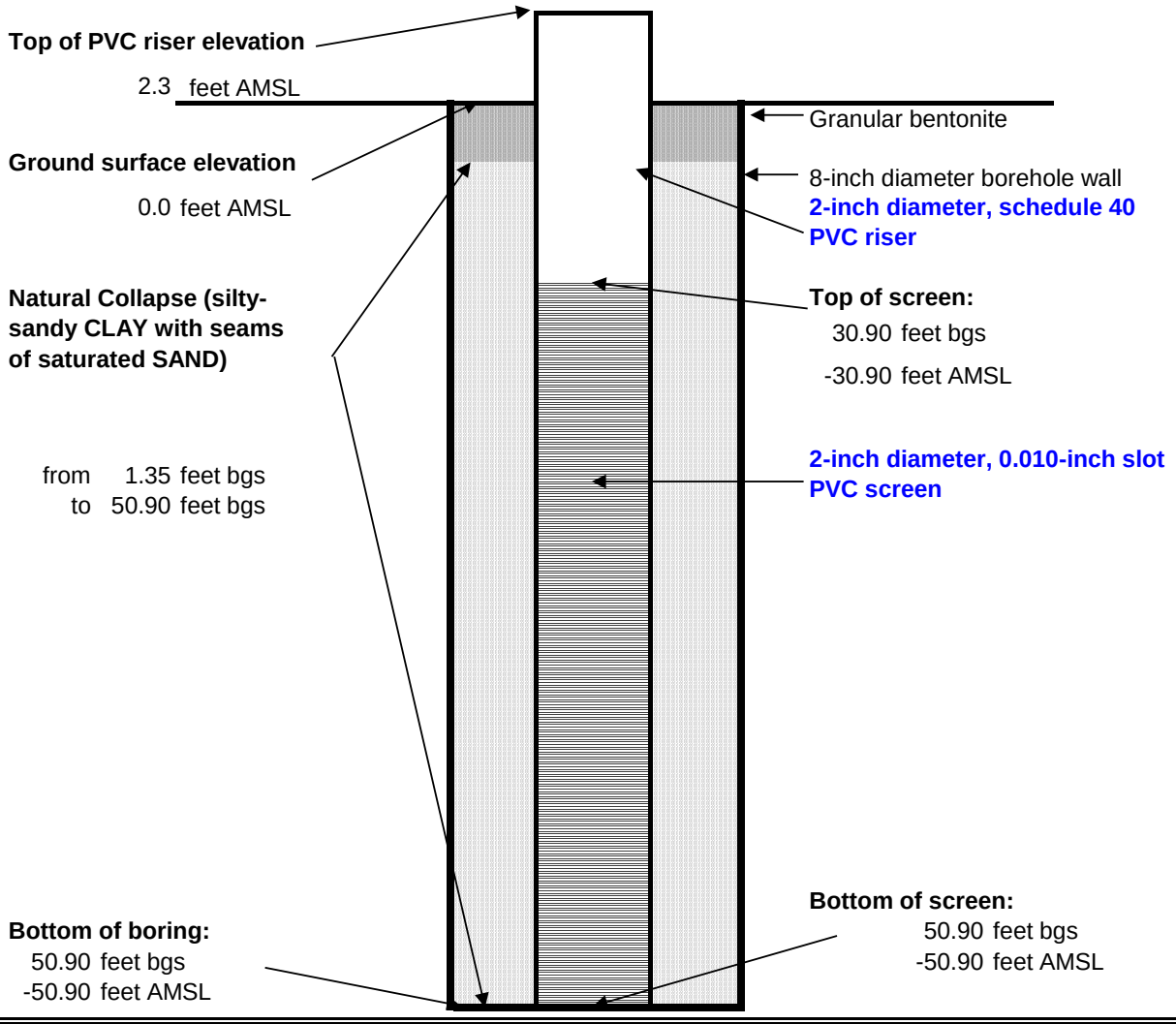
SITE NAME:	Meritor, Grenada	DRILLING RIG:	Geoprobe 7822DT
		DRILL TYPE:	Direct Push
PROJECT #:	MERT-00010	START DATE:	8/24/2015
BORING ID:	IW8-2D	FINISH DATE:	8/24/2015
WELL ID:	IW8-2D	LOGGED BY:	NAH
COUNTY:	Grenada	WEATHER:	Sunny, 64-85°F
TWP:	Grenada	GROUND ELEV.:	
DRILL CO.:	EFS	NORTHING:	
DRILLER:	J. Tillman	EASTING:	

TOT DEPTH:	50.90	feet bgs
TOC ELEV.:	181.980	
SCREEN FROM:	50.90	feet bgs
SCREEN TO:	30.90	feet bgs
SCREEN TYPE:	2-inch PVC	
SCREEN SIZE:	0.020-inch slot	
CASING TYPE:	schedule 40 PVC	
CASING SIZE:	2-inch diameter	
PUMP TYPE:	N/A	

LEGEND:

Granular Bentonite	
Natural Collapse	

NOTES: AMSL: Above Mean Sea Level
bgs: below ground surface



WELL CONSTRUCTION DIAGRAM

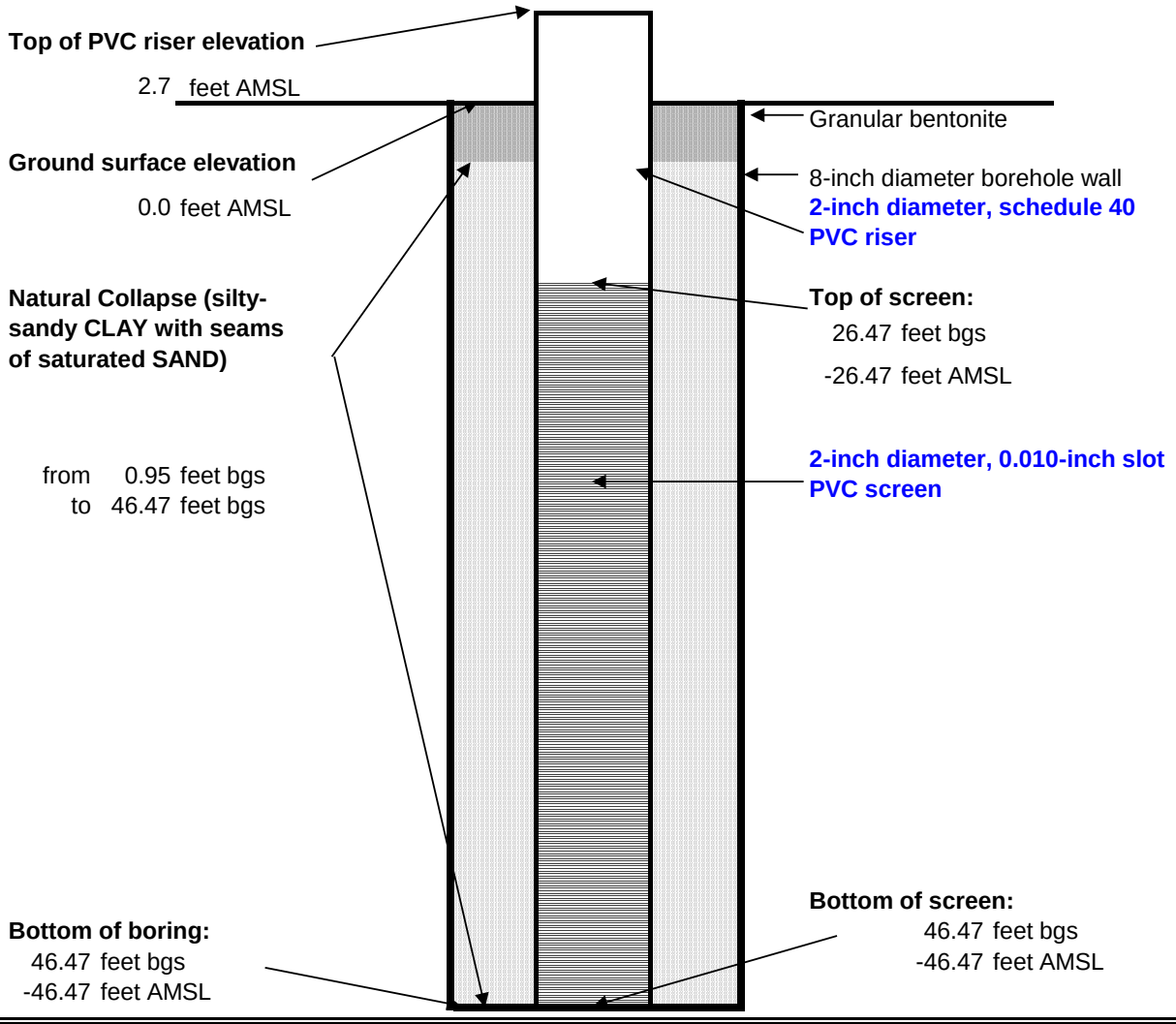
SITE NAME:	Meritor, Grenada	DRILLING RIG:	Geoprobe 7822DT
		DRILL TYPE:	Direct Push
PROJECT #:	MERT-00010	START DATE:	8/24/2015
BORING ID:	IW8-3D	FINISH DATE:	8/24/2015
WELL ID:	IW8-3D	LOGGED BY:	NAH
COUNTY:	Grenada	WEATHER:	Sunny, 64-85°F
TWP:	Grenada	GROUND ELEV.:	
DRILL CO.:	EFS	NORTHING:	
DRILLER:	J. Tillman	EASTING:	

TOT DEPTH:	46.47	feet bgs
TOC ELEV.:	182.336	
SCREEN FROM:	46.47	feet bgs
SCREEN TO:	26.47	feet bgs
SCREEN TYPE:	2-inch PVC	
SCREEN SIZE:	0.020-inch slot	
CASING TYPE:	schedule 40 PVC	
CASING SIZE:	2-inch diameter	
PUMP TYPE:	N/A	

LEGEND:

Granular Bentonite	
Natural Collapse	

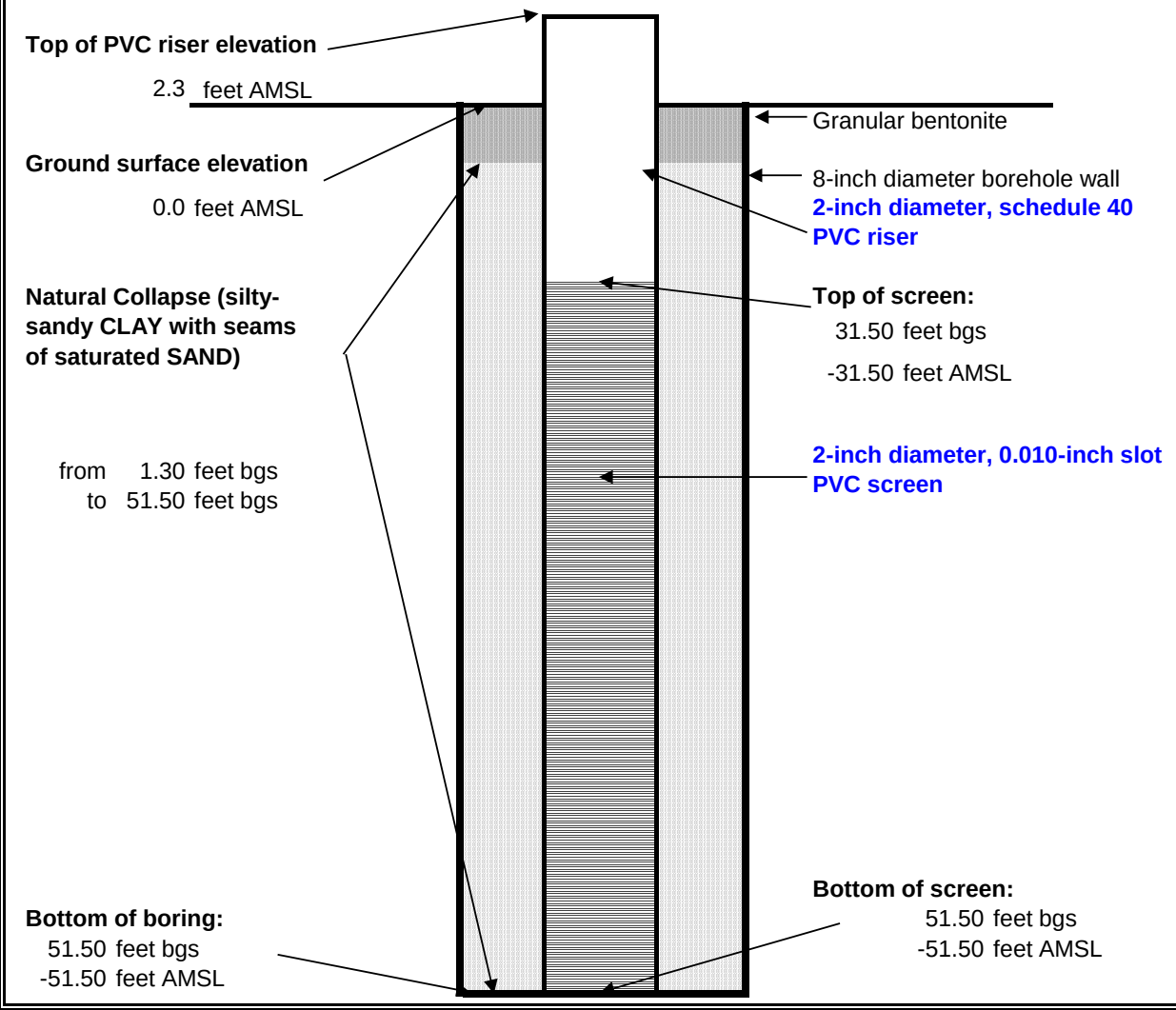
NOTES: AMSL: Above Mean Sea Level
bgs: below ground surface



WELL CONSTRUCTION DIAGRAM

SITE NAME:	Meritor, Grenada	DRILLING RIG:	Geoprobe 7822DT
		DRILL TYPE:	Direct Push
PROJECT #:	MERT-00010	START DATE:	8/24/2015
BORING ID:	IW8-4D	FINISH DATE:	8/24/2015
WELL ID:	IW8-4D	LOGGED BY:	NAH
COUNTY:	Grenada	WEATHER:	Sunny, 64-85°F
TWP:	Grenada	GROUND ELEV.:	
DRILL CO.:	EFS	NORTHING:	
DRILLER:	J. Tillman	EASTING:	

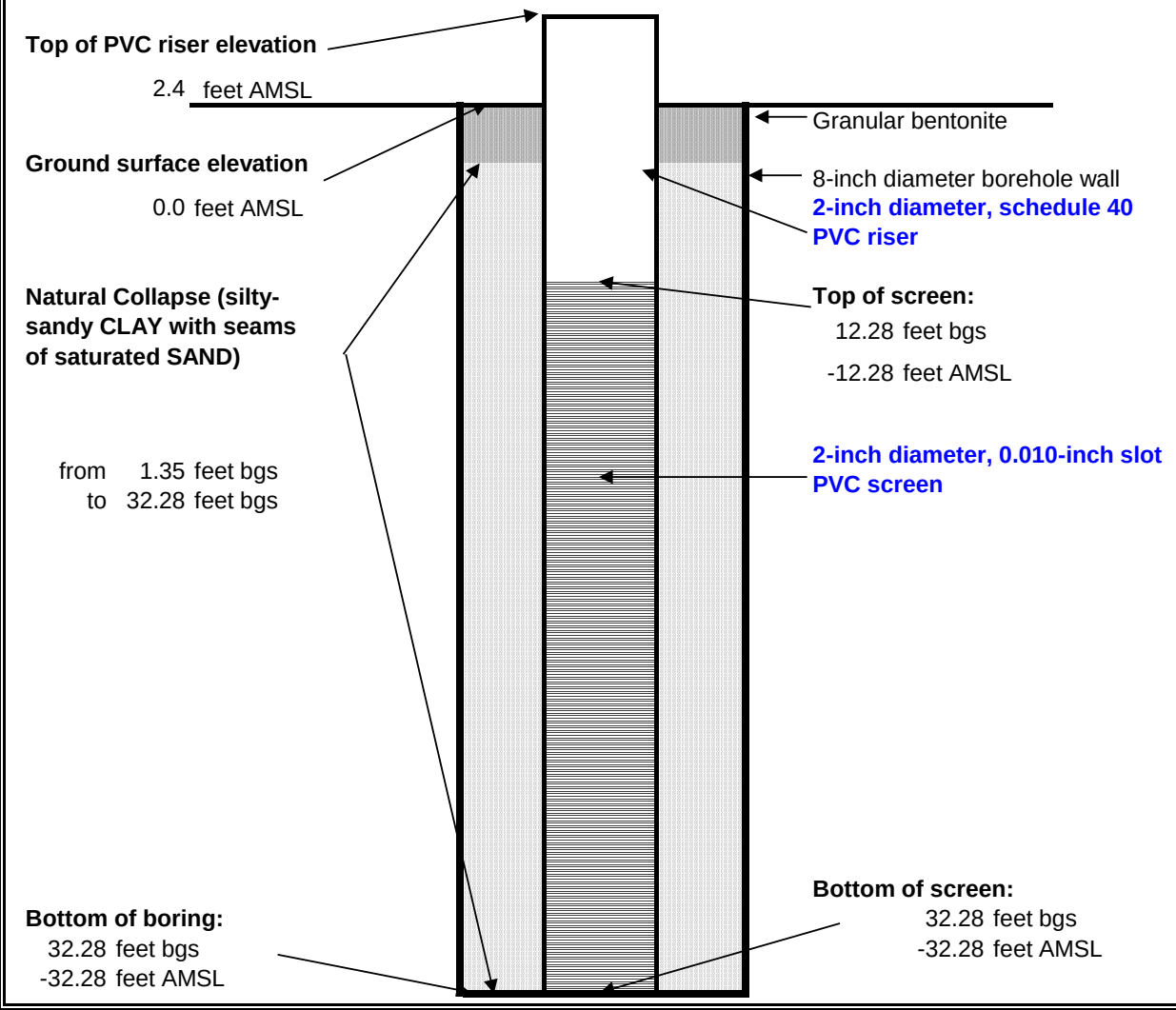
TOT DEPTH:	51.50	feet bgs	**LEGEND:**
TOC ELEV.:	181.771		Granular Bentonite
SCREEN FROM:	51.50	feet bgs	Natural Collapse
SCREEN TO:	31.50	feet bgs	
SCREEN TYPE:	2-inch PVC		
SCREEN SIZE:	0.020-inch slot		**NOTES:** AMSL: Above Mean Sea Level
CASING TYPE:	schedule 40 PVC		bgs: below ground surface
CASING SIZE:	2-inch diameter		
PUMP TYPE:	N/A		



WELL CONSTRUCTION DIAGRAM

SITE NAME:	Meritor, Grenada	DRILLING RIG:	Geoprobe 7822DT
		DRILL TYPE:	Direct Push
PROJECT #:	MERT-00010	START DATE:	8/27/2015
BORING ID:	IW8-5S	FINISH DATE:	8/27/2015
WELL ID:	IW8-5S	LOGGED BY:	NAH
COUNTY:	Grenada	WEATHER:	Sunny, 63-85°F
TWP:	Grenada	GROUND ELEV.:	
DRILL CO.:	EFS	NORTHING:	
DRILLER:	J. Tillman	EASTING:	

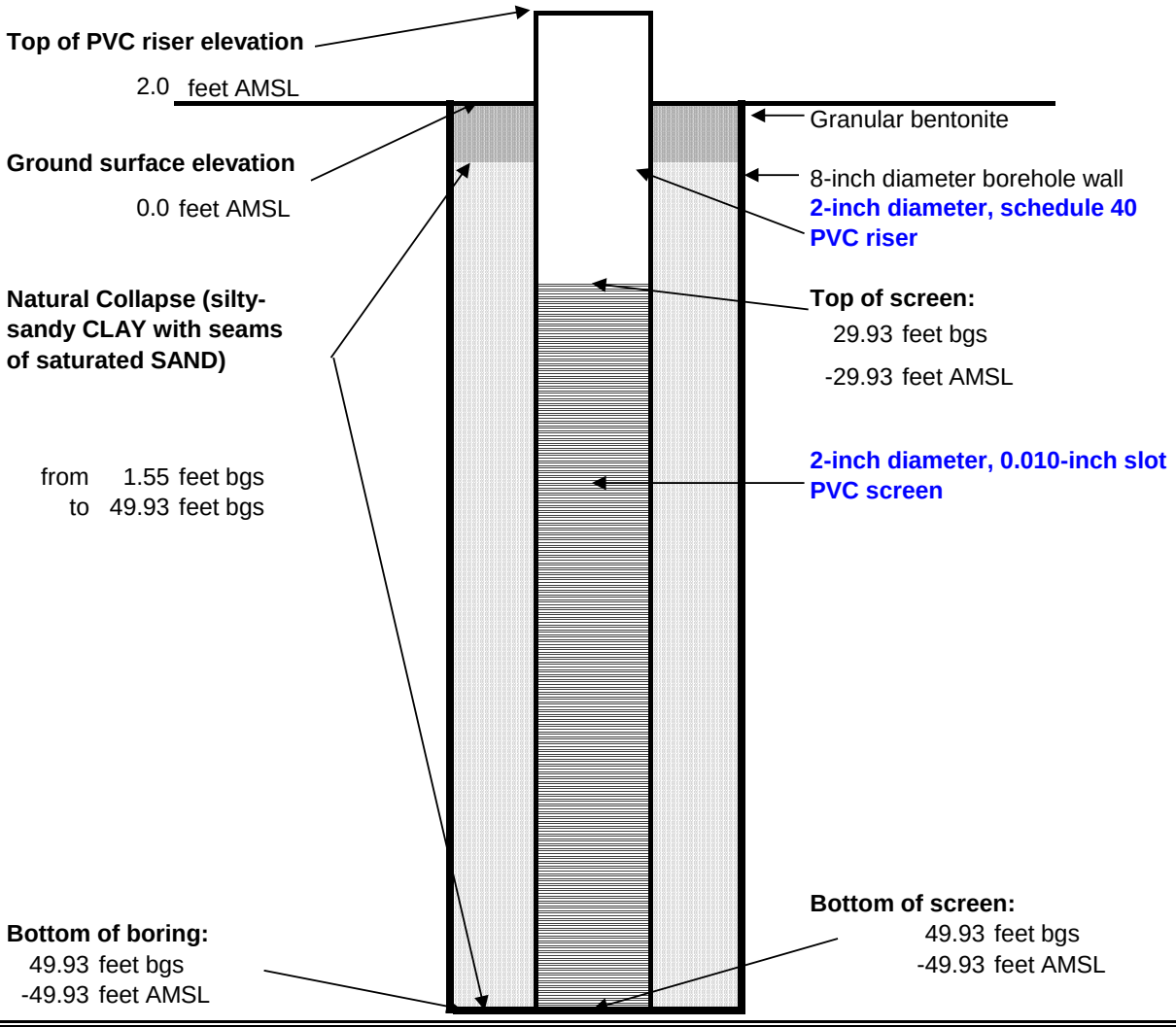
TOT DEPTH:	32.28	feet bgs	**LEGEND:**
TOC ELEV.:	181.698		Granular Bentonite
SCREEN FROM:	32.28	feet bgs	Natural Collapse
SCREEN TO:	12.28	feet bgs	
SCREEN TYPE:	2-inch PVC		
SCREEN SIZE:	0.020-inch slot		**NOTES:** AMSL: Above Mean Sea Level
CASING TYPE:	schedule 40 PVC		bgs: below ground surface
CASING SIZE:	2-inch diameter		
PUMP TYPE:	N/A		



WELL CONSTRUCTION DIAGRAM

SITE NAME:	Meritor, Grenada	DRILLING RIG:	Geoprobe 7822DT
		DRILL TYPE:	Direct Push
PROJECT #:	MERT-00010	START DATE:	8/23/2015
BORING ID:	IW8-5D	FINISH DATE:	8/23/2015
WELL ID:	IW8-5D	LOGGED BY:	NAH
COUNTY:	Grenada	WEATHER:	Overcast 75°F
TWP:	Grenada	GROUND ELEV.:	
DRILL CO.:	EFS	NORTHING:	
DRILLER:	J. Tillman	EASTING:	

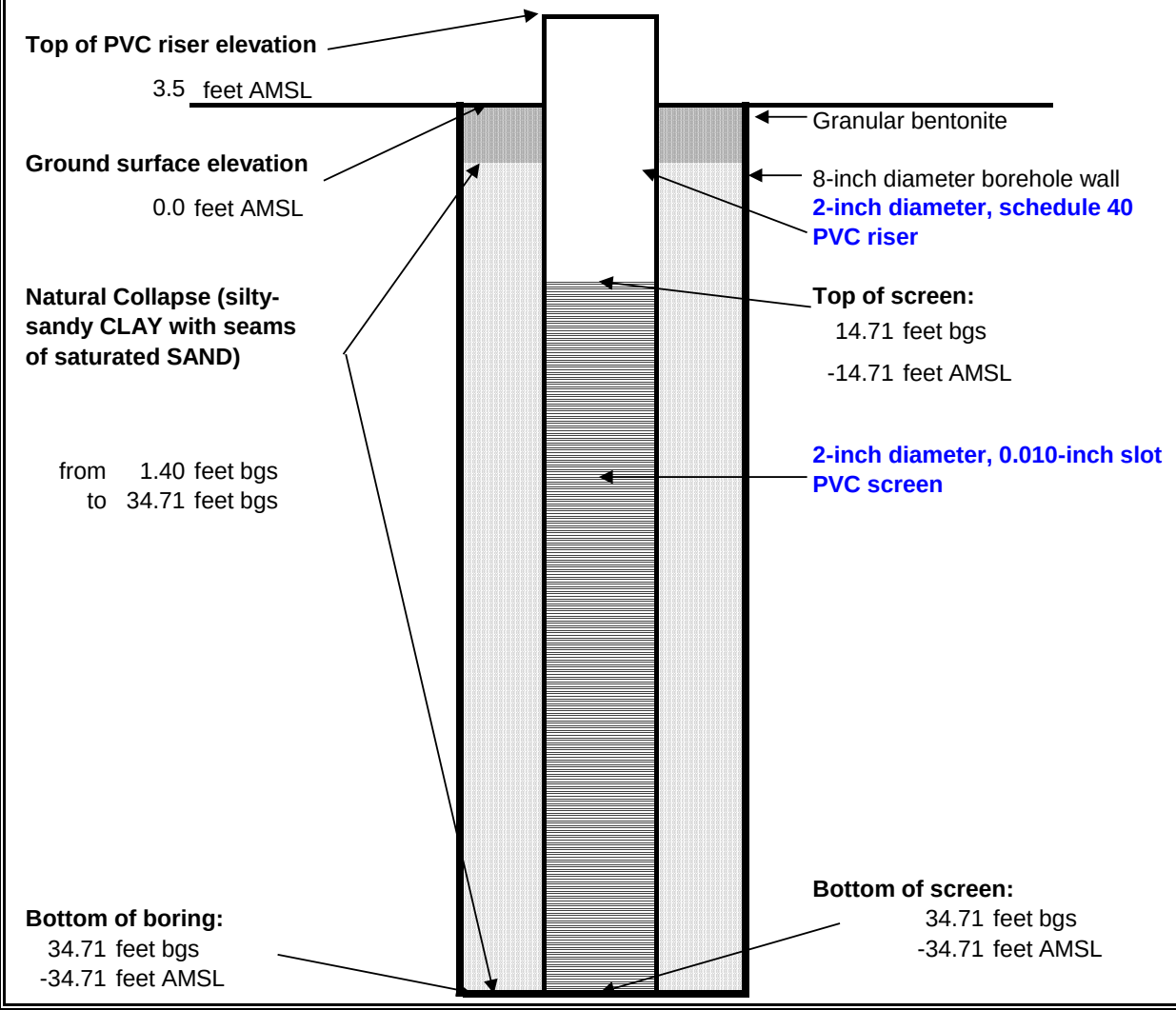
TOT DEPTH:	49.93	feet bgs	**LEGEND:**	
TOC ELEV.:	181.295		Granular Bentonite	
SCREEN FROM:	49.93	feet bgs	Natural Collapse	
SCREEN TO:	29.93	feet bgs		
SCREEN TYPE:	2-inch PVC			
SCREEN SIZE:	0.020-inch slot		**NOTES:** AMSL: Above Mean Sea Level	
CASING TYPE:	schedule 40 PVC		bgs: below ground surface	
CASING SIZE:	2-inch diameter			
PUMP TYPE:	N/A			



WELL CONSTRUCTION DIAGRAM

SITE NAME:	Meritor, Grenada	DRILLING RIG:	Geoprobe 7822DT
		DRILL TYPE:	Direct Push
PROJECT #:	MERT-00010	START DATE:	8/23/2015
BORING ID:	IW9-1S	FINISH DATE:	8/23/2015
WELL ID:	IW9-1S	LOGGED BY:	NAH
COUNTY:	Grenada	WEATHER:	Overcast 75°F
TWP:	Grenada	GROUND ELEV.:	
DRILL CO.:	EFS	NORTHING:	
DRILLER:	J. Tillman	EASTING:	

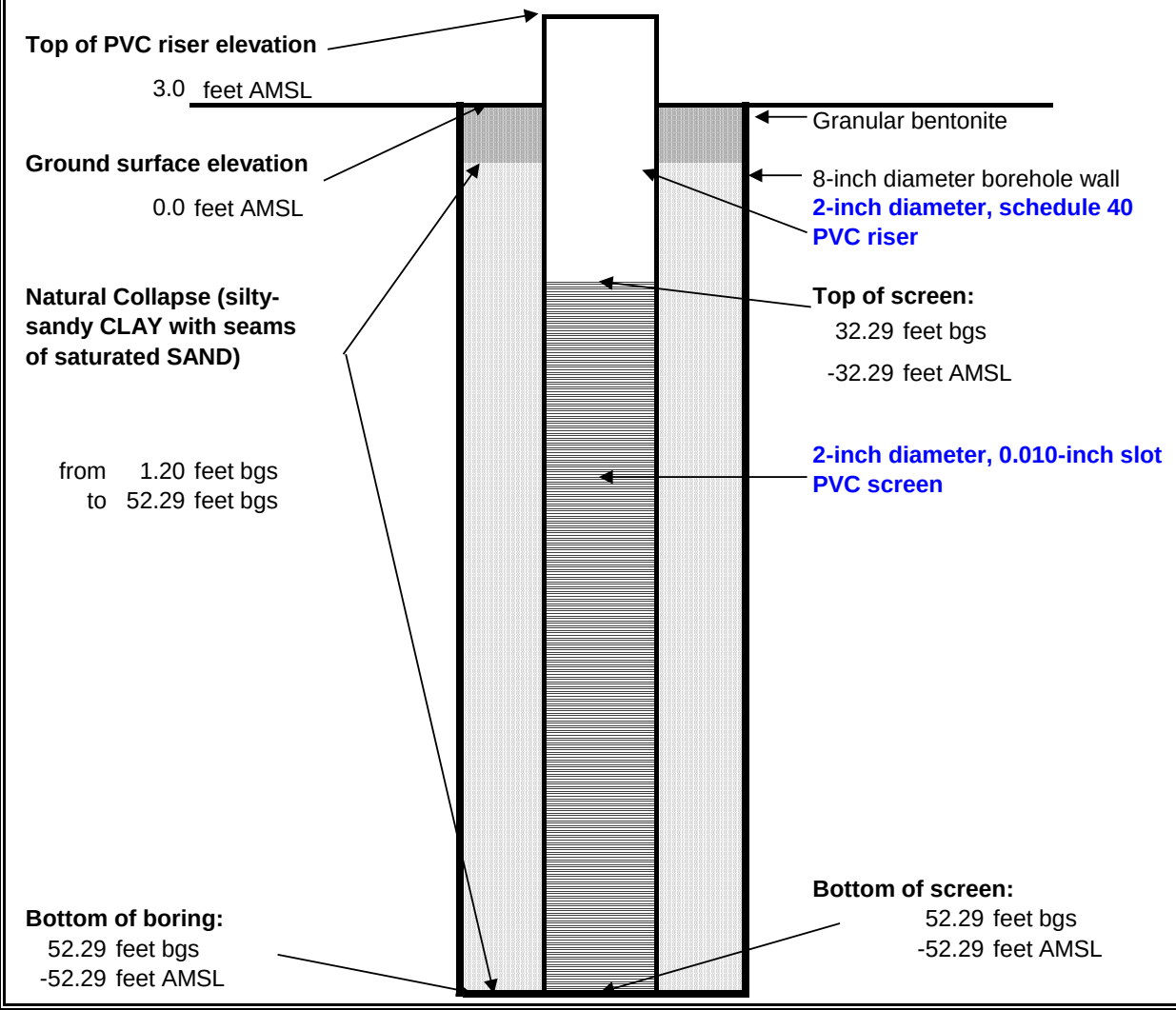
TOT DEPTH:	34.71	feet bgs	**LEGEND:**
TOC ELEV.:	182.778		Granular Bentonite
SCREEN FROM:	34.71	feet bgs	Natural Collapse
SCREEN TO:	14.71	feet bgs	
SCREEN TYPE:	2-inch PVC		
SCREEN SIZE:	0.020-inch slot		**NOTES:** AMSL: Above Mean Sea Level
CASING TYPE:	schedule 40 PVC		bgs: below ground surface
CASING SIZE:	2-inch diameter		
PUMP TYPE:	N/A		



WELL CONSTRUCTION DIAGRAM

SITE NAME:	Meritor, Grenada	DRILLING RIG:	Geoprobe 7822DT
		DRILL TYPE:	Direct Push
PROJECT #:	MERT-00010	START DATE:	8/23/2015
BORING ID:	IW9-1D	FINISH DATE:	8/23/2015
WELL ID:	IW9-1D	LOGGED BY:	NAH
COUNTY:	Grenada	WEATHER:	Overcast 75°F
TWP:	Grenada	GROUND ELEV.:	
DRILL CO.:	EFS	NORTHING:	
DRILLER:	J. Tillman	EASTING:	

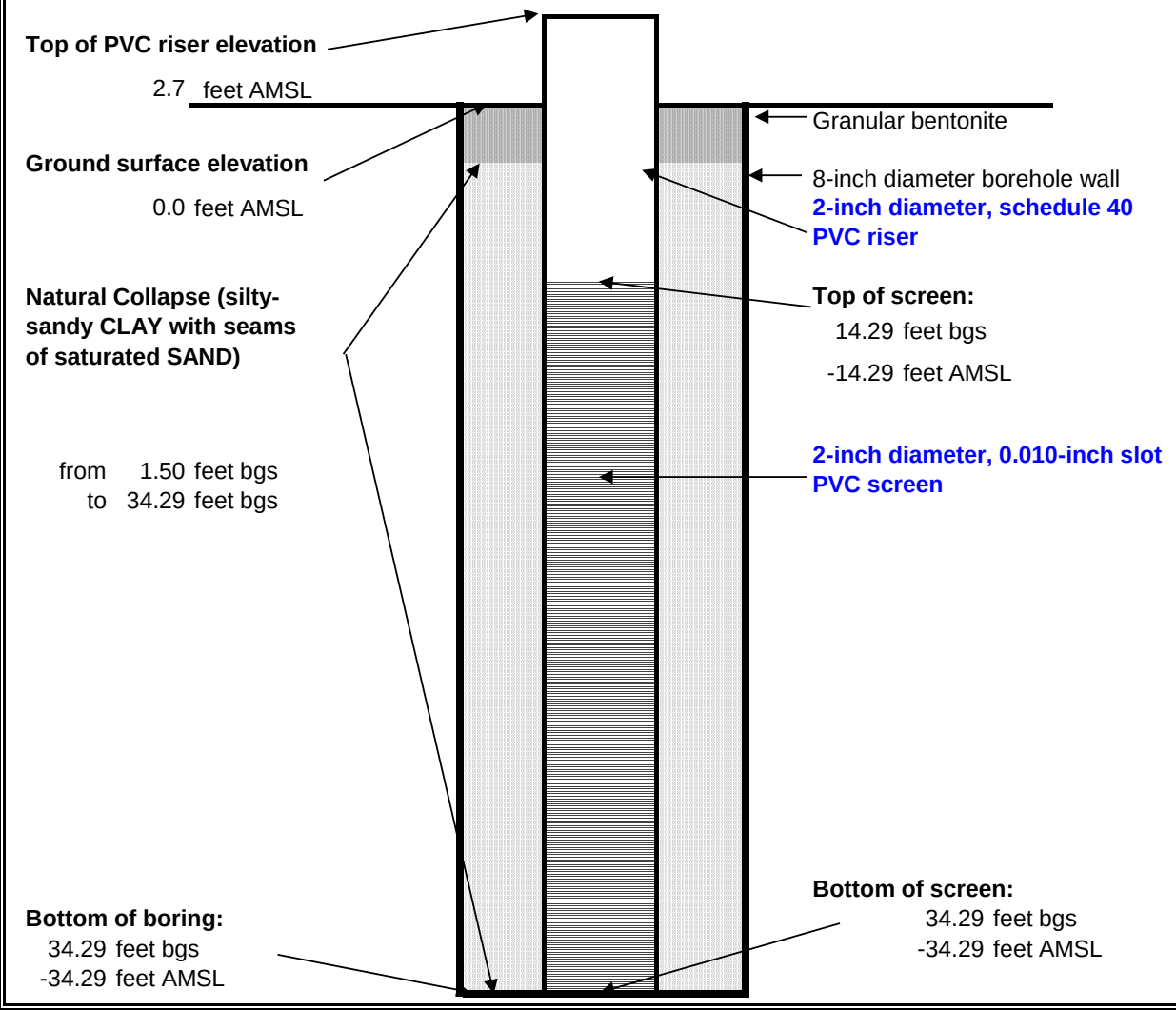
TOT DEPTH:	52.29	feet bgs	**LEGEND:**	
TOC ELEV.:	182.252		Granular Bentonite	
SCREEN FROM:	52.29	feet bgs	Natural Collapse	
SCREEN TO:	32.29	feet bgs		
SCREEN TYPE:	2-inch PVC			
SCREEN SIZE:	0.020-inch slot		**NOTES:** AMSL: Above Mean Sea Level	
CASING TYPE:	schedule 40 PVC		bgs: below ground surface	
CASING SIZE:	2-inch diameter			
PUMP TYPE:	N/A			



WELL CONSTRUCTION DIAGRAM

SITE NAME:	Meritor, Grenada	DRILLING RIG:	Geoprobe 7822DT
		DRILL TYPE:	Direct Push
PROJECT #:	MERT-00010	START DATE:	8/23/2015
BORING ID:	IW9-2S	FINISH DATE:	8/23/2015
WELL ID:	IW9-2S	LOGGED BY:	NAH
COUNTY:	Grenada	WEATHER:	Overcast 75°F
TWP:	Grenada	GROUND ELEV.:	
DRILL CO.:	EFS	NORTHING:	
DRILLER:	J. Tillman	EASTING:	

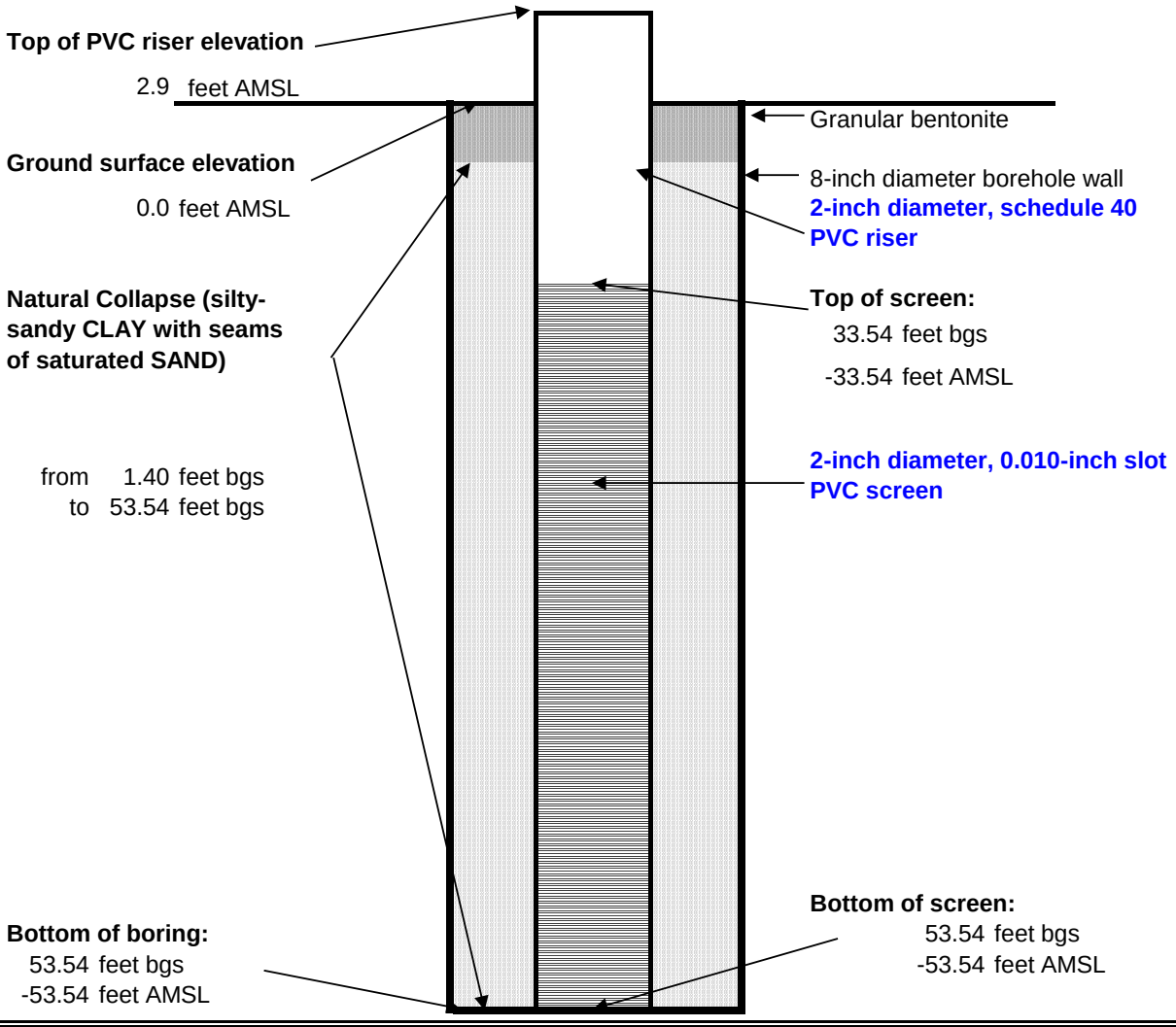
TOT DEPTH:	34.29	feet bgs	**LEGEND:**
TOC ELEV.:	181.908		Granular Bentonite
SCREEN FROM:	34.29	feet bgs	Natural Collapse
SCREEN TO:	14.29	feet bgs	
SCREEN TYPE:	2-inch PVC		
SCREEN SIZE:	0.020-inch slot		**NOTES:** AMSL: Above Mean Sea Level
CASING TYPE:	schedule 40 PVC		bgs: below ground surface
CASING SIZE:	2-inch diameter		
PUMP TYPE:	N/A		



WELL CONSTRUCTION DIAGRAM

SITE NAME:	Meritor, Grenada	DRILLING RIG:	Geoprobe 7822DT
		DRILL TYPE:	Direct Push
PROJECT #:	MERT-00010	START DATE:	8/23/2015
BORING ID:	IW9-2D	FINISH DATE:	8/23/2015
WELL ID:	IW9-2D	LOGGED BY:	NAH
COUNTY:	Grenada	WEATHER:	Overcast 75°F
TWP:	Grenada	GROUND ELEV.:	
DRILL CO.:	EFS	NORTHING:	
DRILLER:	J. Tillman	EASTING:	

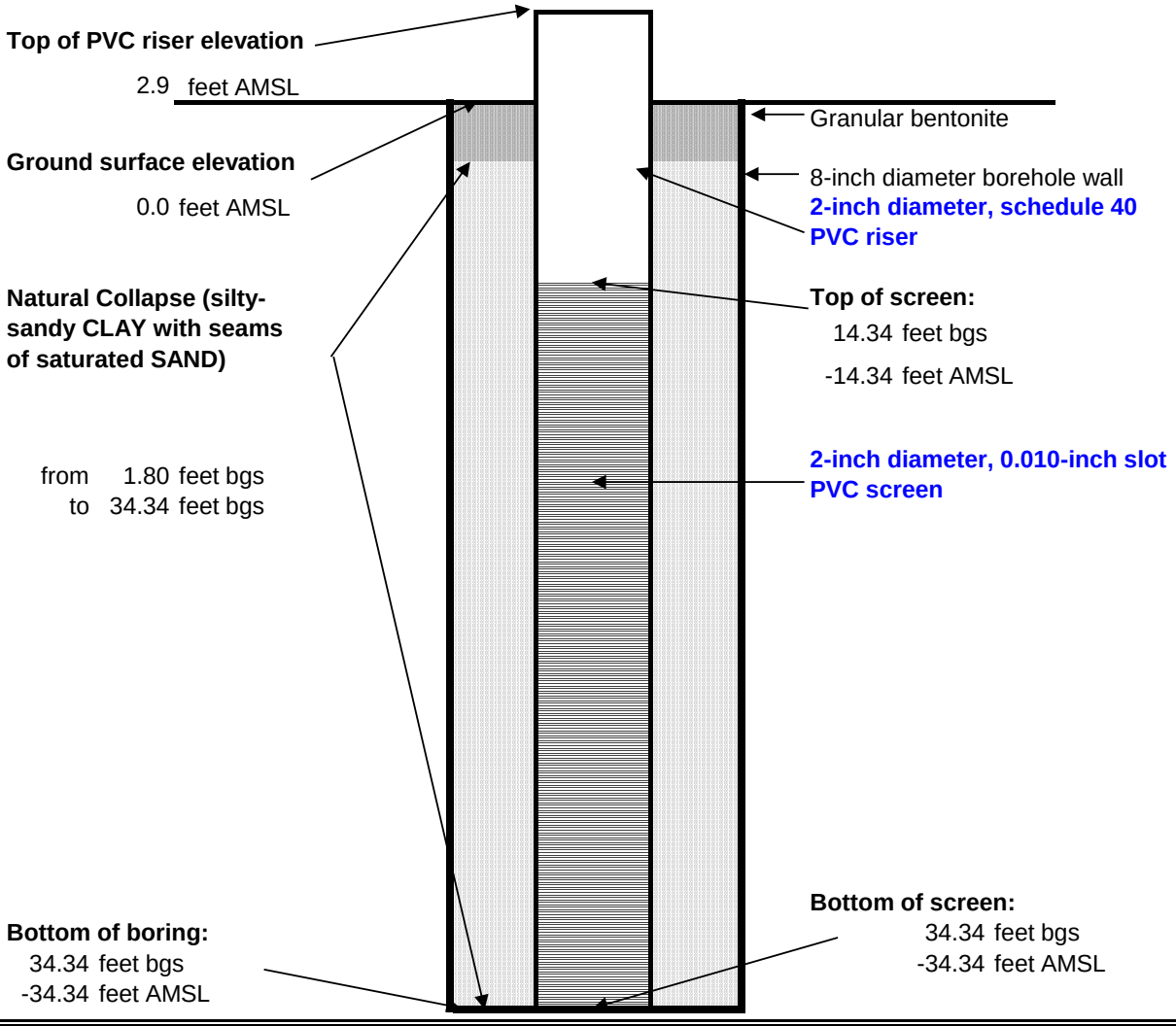
TOT DEPTH:	53.54	feet bgs	**LEGEND:**	
TOC ELEV.:	181.997		Granular Bentonite	
SCREEN FROM:	53.54	feet bgs	Natural Collapse	
SCREEN TO:	33.54	feet bgs		
SCREEN TYPE:	2-inch PVC			
SCREEN SIZE:	0.020-inch slot		**NOTES:** AMSL: Above Mean Sea Level	
CASING TYPE:	schedule 40 PVC		bgs: below ground surface	
CASING SIZE:	2-inch diameter			
PUMP TYPE:	N/A			



WELL CONSTRUCTION DIAGRAM

SITE NAME:	Meritor, Grenada	DRILLING RIG:	Geoprobe 7822DT
		DRILL TYPE:	Direct Push
PROJECT #:	MERT-00010	START DATE:	8/23/2015
BORING ID:	IW9-3S	FINISH DATE:	8/23/2015
WELL ID:	IW9-3S	LOGGED BY:	NAH
COUNTY:	Grenada	WEATHER:	Overcast 75°F
TWP:	Grenada	GROUND ELEV.:	
DRILL CO.:	EFS	NORTHING:	
DRILLER:	J. Tillman	EASTING:	

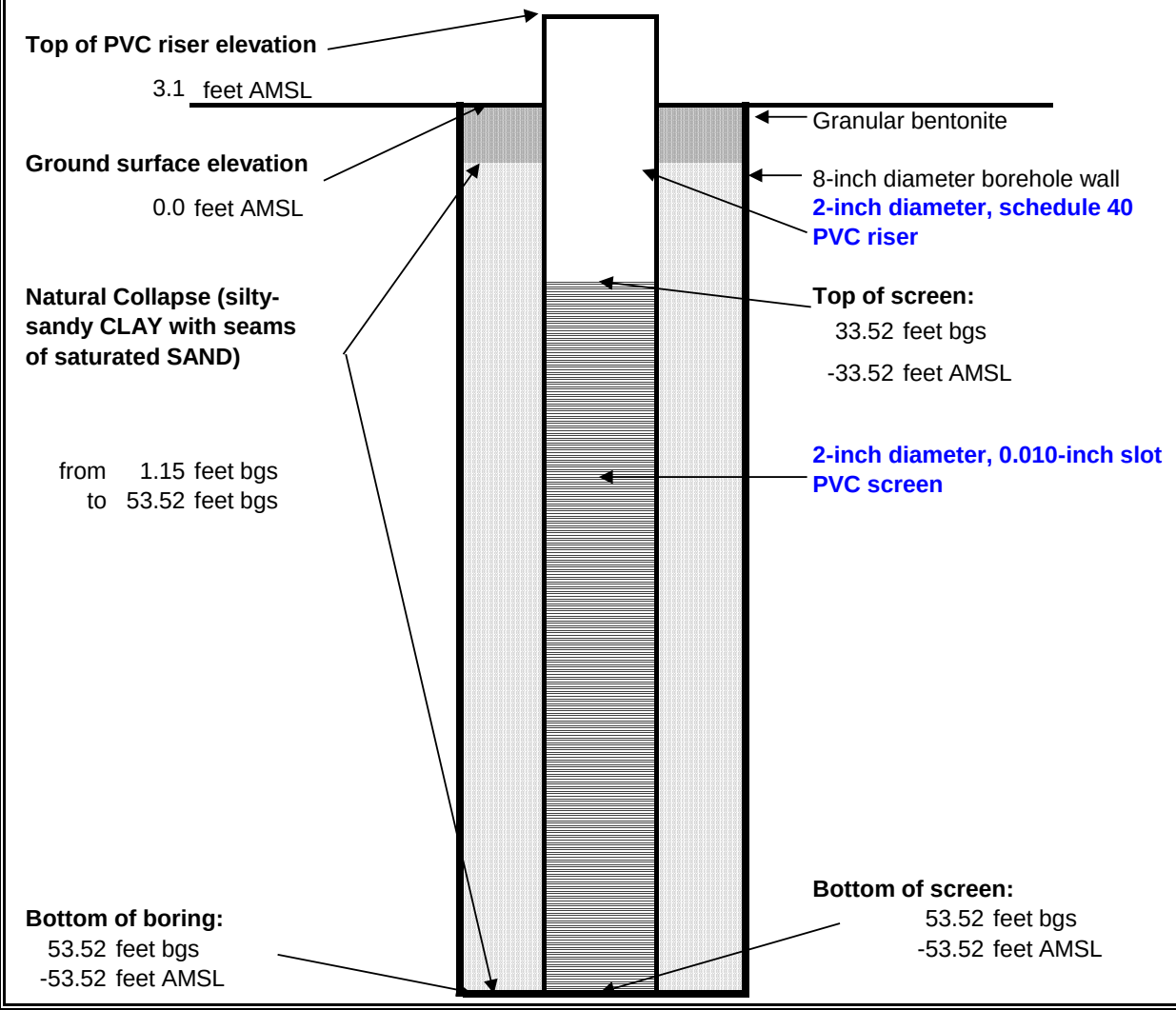
TOT DEPTH:	34.34	feet bgs	**LEGEND:**	
TOC ELEV.:	182.015		Granular Bentonite	
SCREEN FROM:	34.34	feet bgs	Natural Collapse	
SCREEN TO:	14.34	feet bgs		
SCREEN TYPE:	2-inch PVC			
SCREEN SIZE:	0.020-inch slot		**NOTES:** AMSL: Above Mean Sea Level	
CASING TYPE:	schedule 40 PVC		bgs: below ground surface	
CASING SIZE:	2-inch diameter			
PUMP TYPE:	N/A			



WELL CONSTRUCTION DIAGRAM

SITE NAME:	Meritor, Grenada	DRILLING RIG:	Geoprobe 7822DT
		DRILL TYPE:	Direct Push
PROJECT #:	MERT-00010	START DATE:	8/23/2015
BORING ID:	IW9-3D	FINISH DATE:	8/23/2015
WELL ID:	IW9-3D	LOGGED BY:	NAH
COUNTY:	Grenada	WEATHER:	Overcast 75°F
TWP:	Grenada	GROUND ELEV.:	
DRILL CO.:	EFS	NORTHING:	
DRILLER:	J. Tillman	EASTING:	

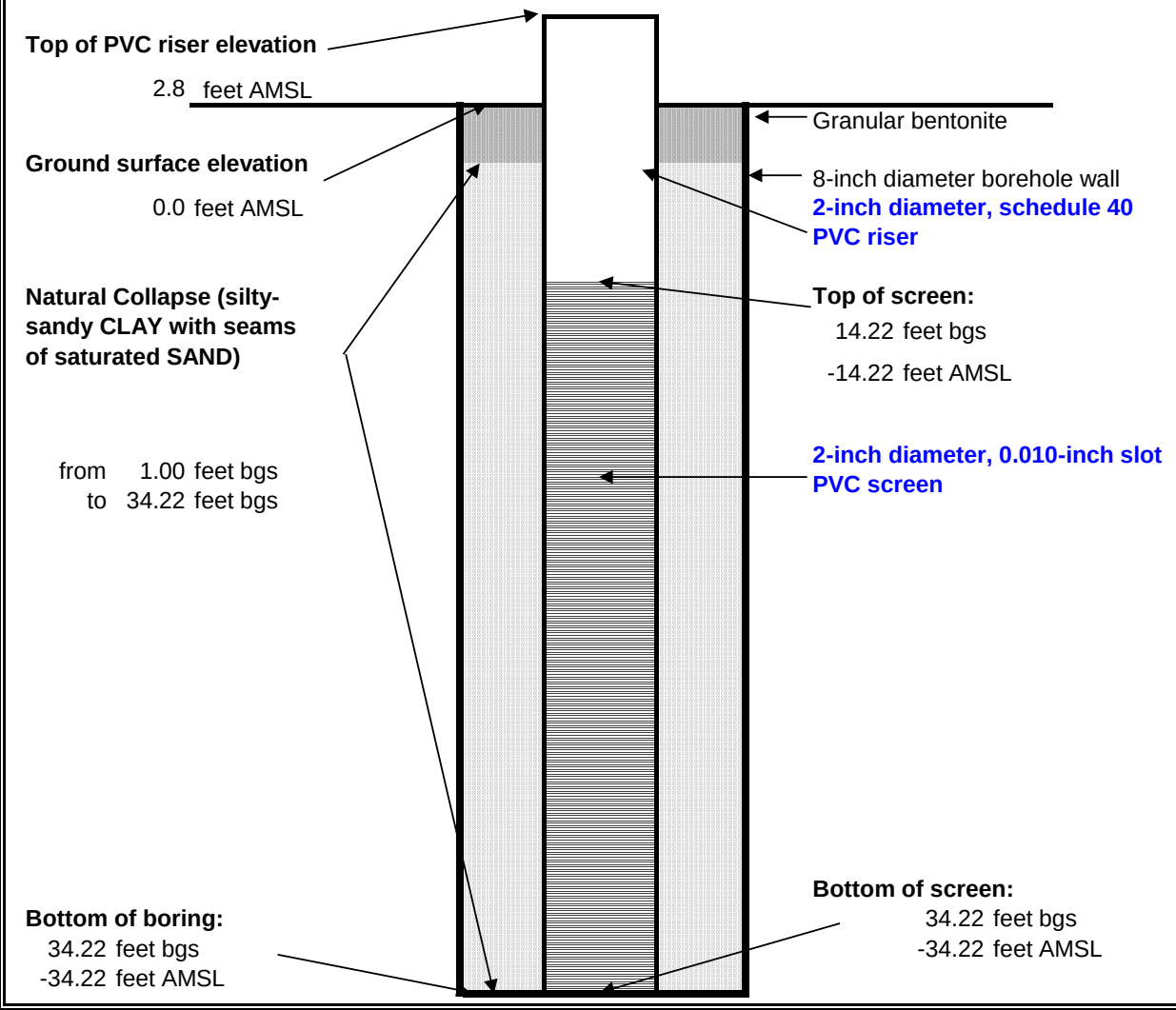
TOT DEPTH:	53.52	feet bgs	**LEGEND:**	
TOC ELEV.:	182.292		Granular Bentonite	
SCREEN FROM:	53.52	feet bgs	Natural Collapse	
SCREEN TO:	33.52	feet bgs		
SCREEN TYPE:	2-inch PVC			
SCREEN SIZE:	0.020-inch slot		**NOTES:** AMSL: Above Mean Sea Level	
CASING TYPE:	schedule 40 PVC		bgs: below ground surface	
CASING SIZE:	2-inch diameter			
PUMP TYPE:	N/A			



WELL CONSTRUCTION DIAGRAM

SITE NAME:	Meritor, Grenada	DRILLING RIG:	Geoprobe 7822DT
		DRILL TYPE:	Direct Push
PROJECT #:	MERT-00010	START DATE:	8/23/2015
BORING ID:	IW9-4S	FINISH DATE:	8/23/2015
WELL ID:	IW9-4S	LOGGED BY:	NAH
COUNTY:	Grenada	WEATHER:	Overcast 75°F
TWP:	Grenada	GROUND ELEV.:	
DRILL CO.:	EFS	NORTHING:	
DRILLER:	J. Tillman	EASTING:	

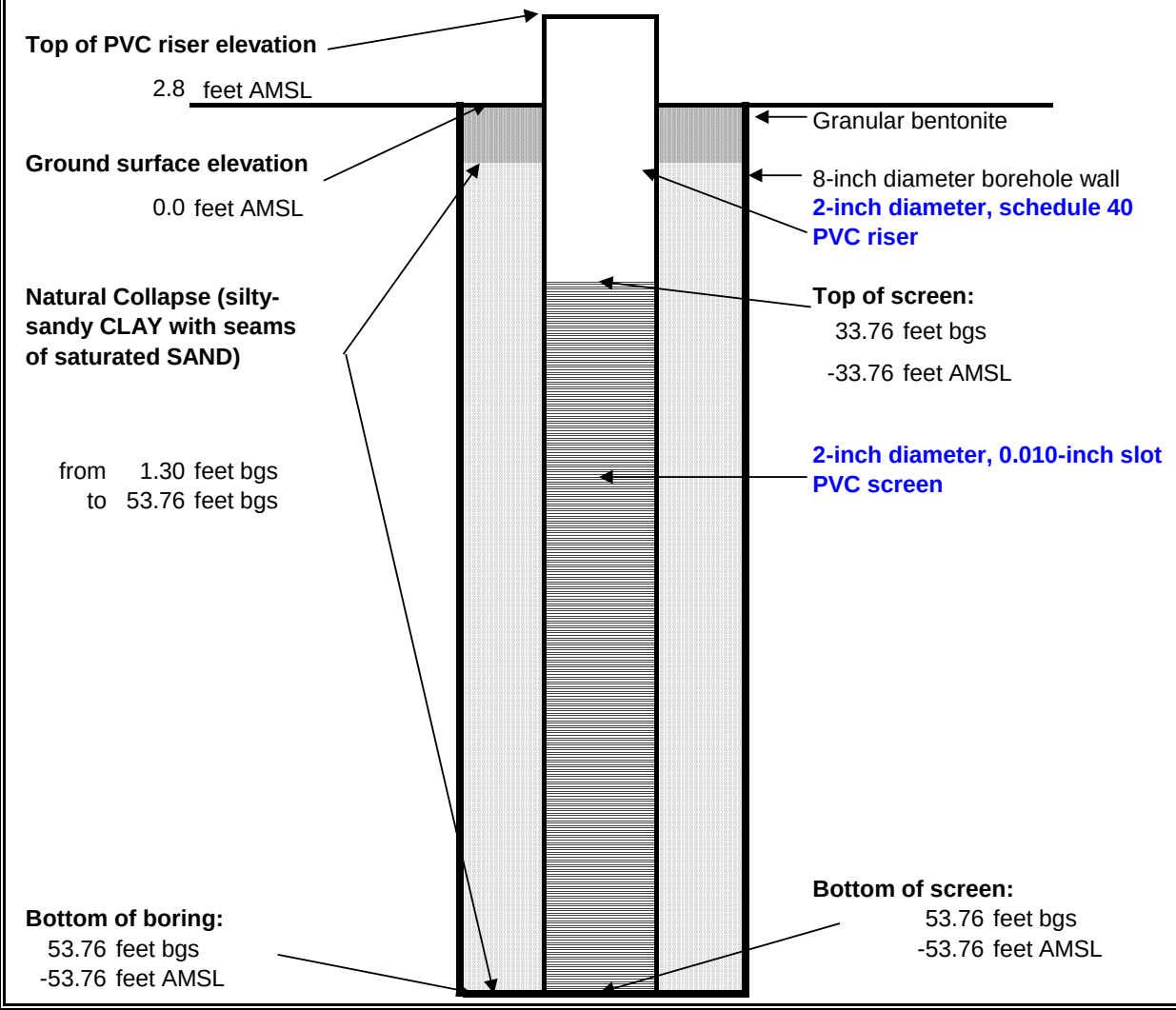
TOT DEPTH:	34.22	feet bgs	**LEGEND:**	
TOC ELEV.:	182.145		Granular Bentonite	
SCREEN FROM:	34.22	feet bgs	Natural Collapse	
SCREEN TO:	14.22	feet bgs		
SCREEN TYPE:	2-inch PVC			
SCREEN SIZE:	0.020-inch slot		**NOTES:** AMSL: Above Mean Sea Level	
CASING TYPE:	schedule 40 PVC		bgs: below ground surface	
CASING SIZE:	2-inch diameter			
PUMP TYPE:	N/A			



WELL CONSTRUCTION DIAGRAM

SITE NAME:	Meritor, Grenada	DRILLING RIG:	Geoprobe 7822DT
		DRILL TYPE:	Direct Push
PROJECT #:	MERT-00010	START DATE:	8/22/2015
BORING ID:	IW9-4D	FINISH DATE:	8/22/2015
WELL ID:	IW9-4D	LOGGED BY:	NAH
COUNTY:	Grenada	WEATHER:	Overcast 74°F Light Rain
TWP:	Grenada	GROUND ELEV.:	
DRILL CO.:	EFS	NORTHING:	
DRILLER:	J. Tillman	EASTING:	

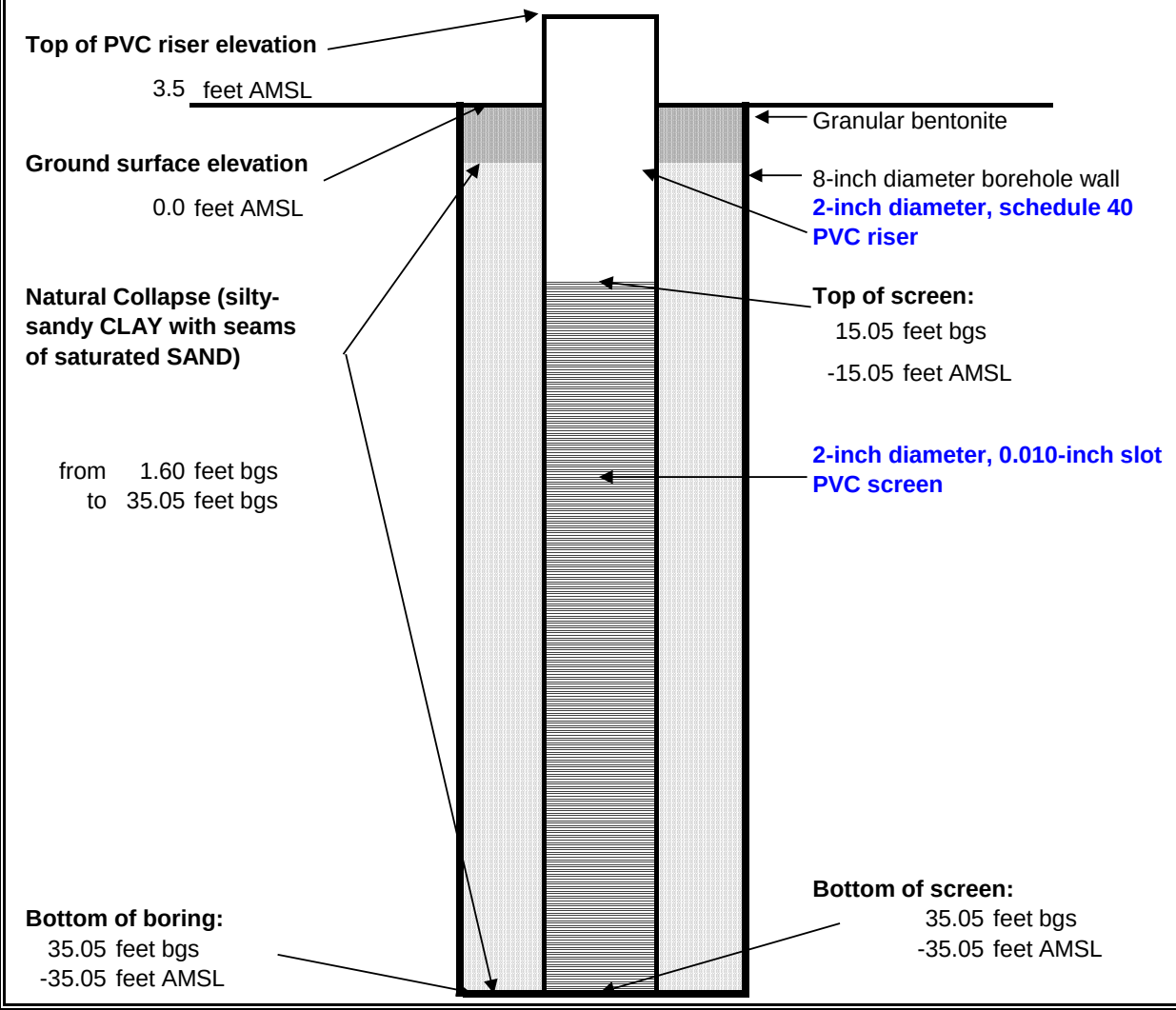
TOT DEPTH:	53.76	feet bgs	**LEGEND:**
TOC ELEV.:	182.153		Granular Bentonite
SCREEN FROM:	53.76	feet bgs	Natural Collapse
SCREEN TO:	33.76	feet bgs	
SCREEN TYPE:	2-inch PVC		
SCREEN SIZE:	0.020-inch slot		**NOTES:** AMSL: Above Mean Sea Level
CASING TYPE:	schedule 40 PVC		bgs: below ground surface
CASING SIZE:	2-inch diameter		
PUMP TYPE:	N/A		



WELL CONSTRUCTION DIAGRAM

SITE NAME:	Meritor, Grenada	DRILLING RIG:	Geoprobe 7822DT
		DRILL TYPE:	Direct Push
PROJECT #:	MERT-00010	START DATE:	8/22/2015
BORING ID:	IW9-5S	FINISH DATE:	8/22/2015
WELL ID:	IW9-5S	LOGGED BY:	NAH
COUNTY:	Grenada	WEATHER:	Overcast 74°F Light Rain
TWP:	Grenada	GROUND ELEV.:	
DRILL CO.:	EFS	NORTHING:	
DRILLER:	J. Tillman	EASTING:	

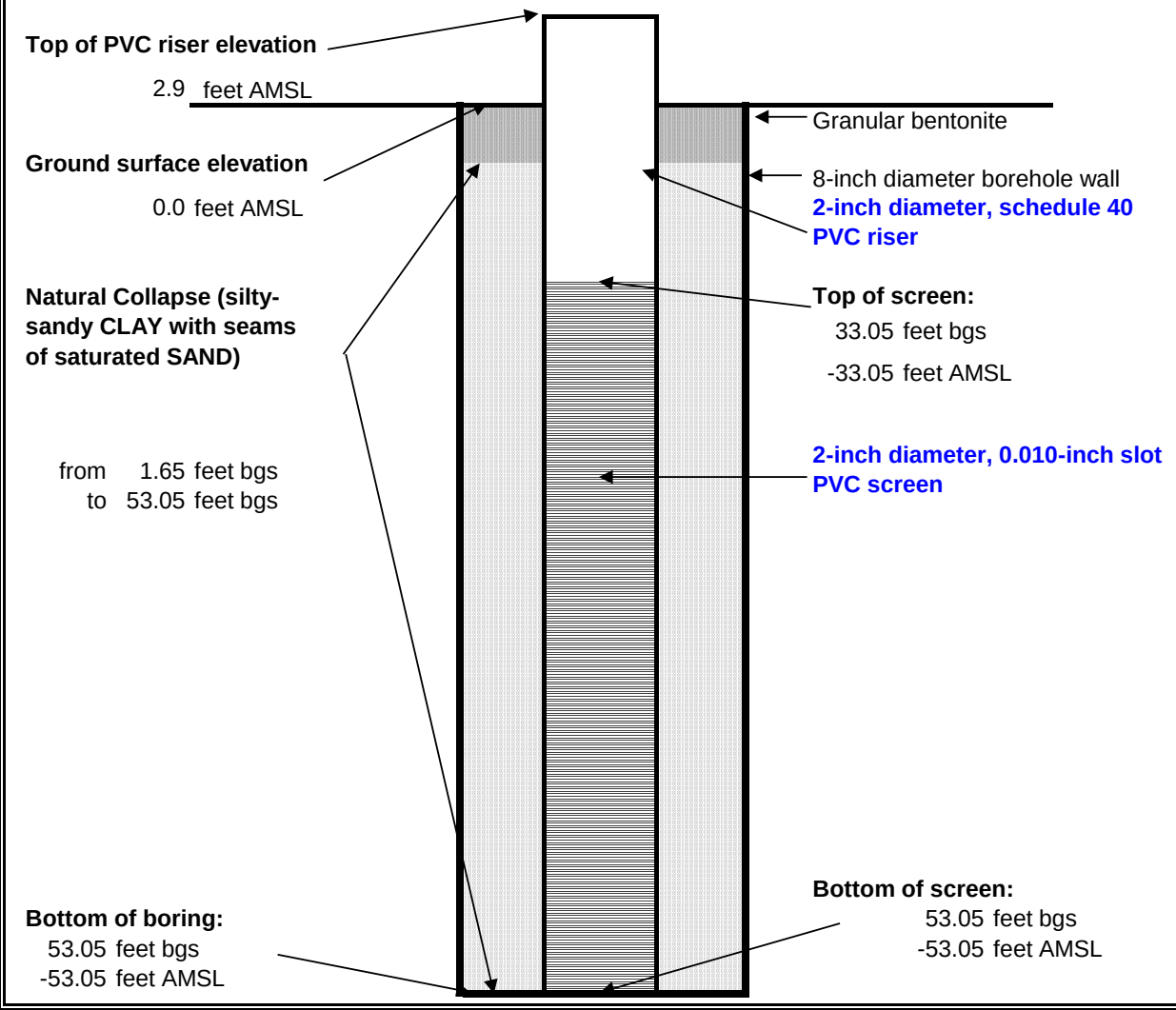
TOT DEPTH:	35.05	feet bgs	**LEGEND:**
TOC ELEV.:	182.805		Granular Bentonite
SCREEN FROM:	35.05	feet bgs	Natural Collapse
SCREEN TO:	15.05	feet bgs	
SCREEN TYPE:	2-inch PVC		
SCREEN SIZE:	0.020-inch slot		**NOTES:** AMSL: Above Mean Sea Level
CASING TYPE:	schedule 40 PVC		bgs: below ground surface
CASING SIZE:	2-inch diameter		
PUMP TYPE:	N/A		



WELL CONSTRUCTION DIAGRAM

SITE NAME:	Meritor, Grenada	DRILLING RIG:	Geoprobe 7822DT
		DRILL TYPE:	Direct Push
PROJECT #:	MERT-00010	START DATE:	8/22/2015
BORING ID:	IW9-5D	FINISH DATE:	8/22/2015
WELL ID:	IW9-5D	LOGGED BY:	NAH
COUNTY:	Grenada	WEATHER:	Overcast 74°F Light Rain
TWP:	Grenada	GROUND ELEV.:	
DRILL CO.:	EFS	NORTHING:	
DRILLER:	J. Tillman	EASTING:	

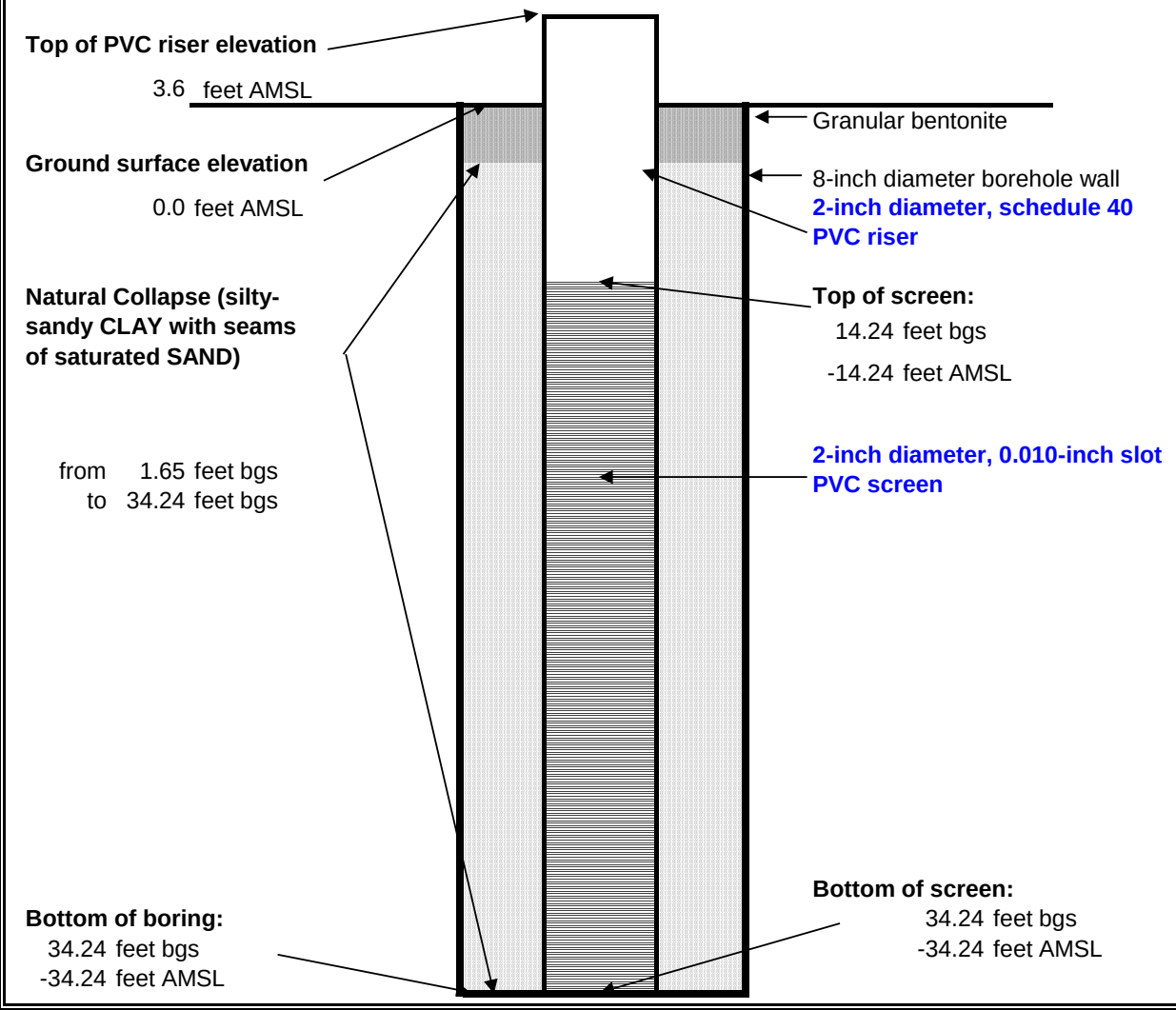
TOT DEPTH:	53.05	feet bgs	**LEGEND:**
TOC ELEV.:	182.264		Granular Bentonite
SCREEN FROM:	53.05	feet bgs	Natural Collapse
SCREEN TO:	33.05	feet bgs	
SCREEN TYPE:	2-inch PVC		
SCREEN SIZE:	0.020-inch slot		**NOTES:** AMSL: Above Mean Sea Level
CASING TYPE:	schedule 40 PVC		bgs: below ground surface
CASING SIZE:	2-inch diameter		
PUMP TYPE:	N/A		



WELL CONSTRUCTION DIAGRAM

SITE NAME:	Meritor, Grenada	DRILLING RIG:	Geoprobe 7822DT
		DRILL TYPE:	Direct Push
PROJECT #:	MERT-00010	START DATE:	8/22/2015
BORING ID:	IW10-1S	FINISH DATE:	8/22/2015
WELL ID:	IW10-1S	LOGGED BY:	NAH
COUNTY:	Grenada	WEATHER:	Overcast 74°F Light Rain
TWP:	Grenada	GROUND ELEV.:	
DRILL CO.:	EFS	NORTHING:	
DRILLER:	J. Tillman	EASTING:	

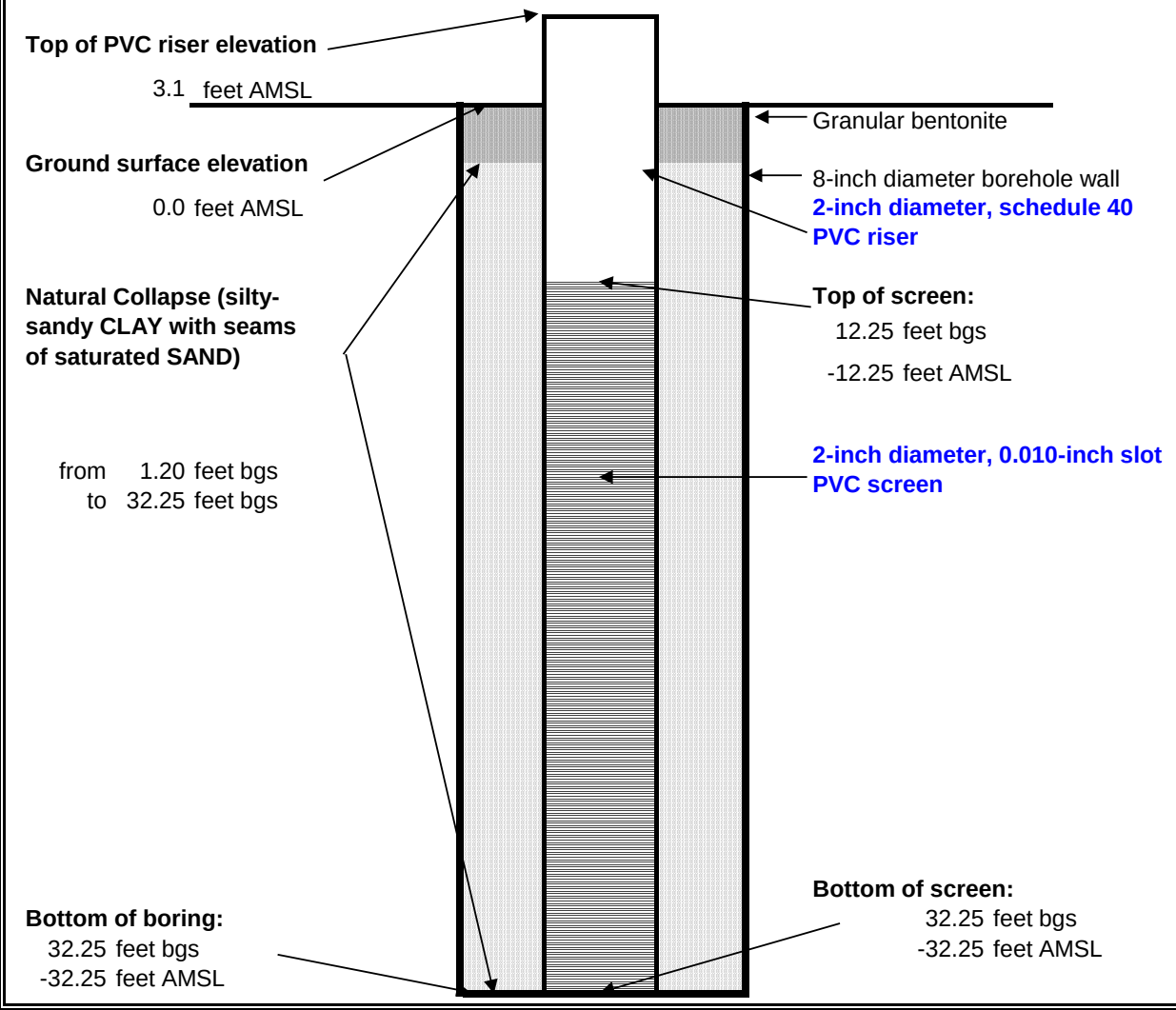
TOT DEPTH:	34.24	feet bgs	**LEGEND:**
TOC ELEV.:	182.976		Granular Bentonite
SCREEN FROM:	34.24	feet bgs	Natural Collapse
SCREEN TO:	14.24	feet bgs	
SCREEN TYPE:	2-inch PVC		
SCREEN SIZE:	0.020-inch slot		**NOTES:** AMSL: Above Mean Sea Level
CASING TYPE:	schedule 40 PVC		bgs: below ground surface
CASING SIZE:	2-inch diameter		
PUMP TYPE:	N/A		



WELL CONSTRUCTION DIAGRAM

SITE NAME:	Meritor, Grenada	DRILLING RIG:	Geoprobe 7822DT
		DRILL TYPE:	Direct Push
PROJECT #:	MERT-00010	START DATE:	8/22/2015
BORING ID:	IW10-2S	FINISH DATE:	8/22/2015
WELL ID:	IW10-2S	LOGGED BY:	NAH
COUNTY:	Grenada	WEATHER:	Overcast 74°F Light Rain
TWP:	Grenada	GROUND ELEV.:	
DRILL CO.:	EFS	NORTHING:	
DRILLER:	J. Tillman	EASTING:	

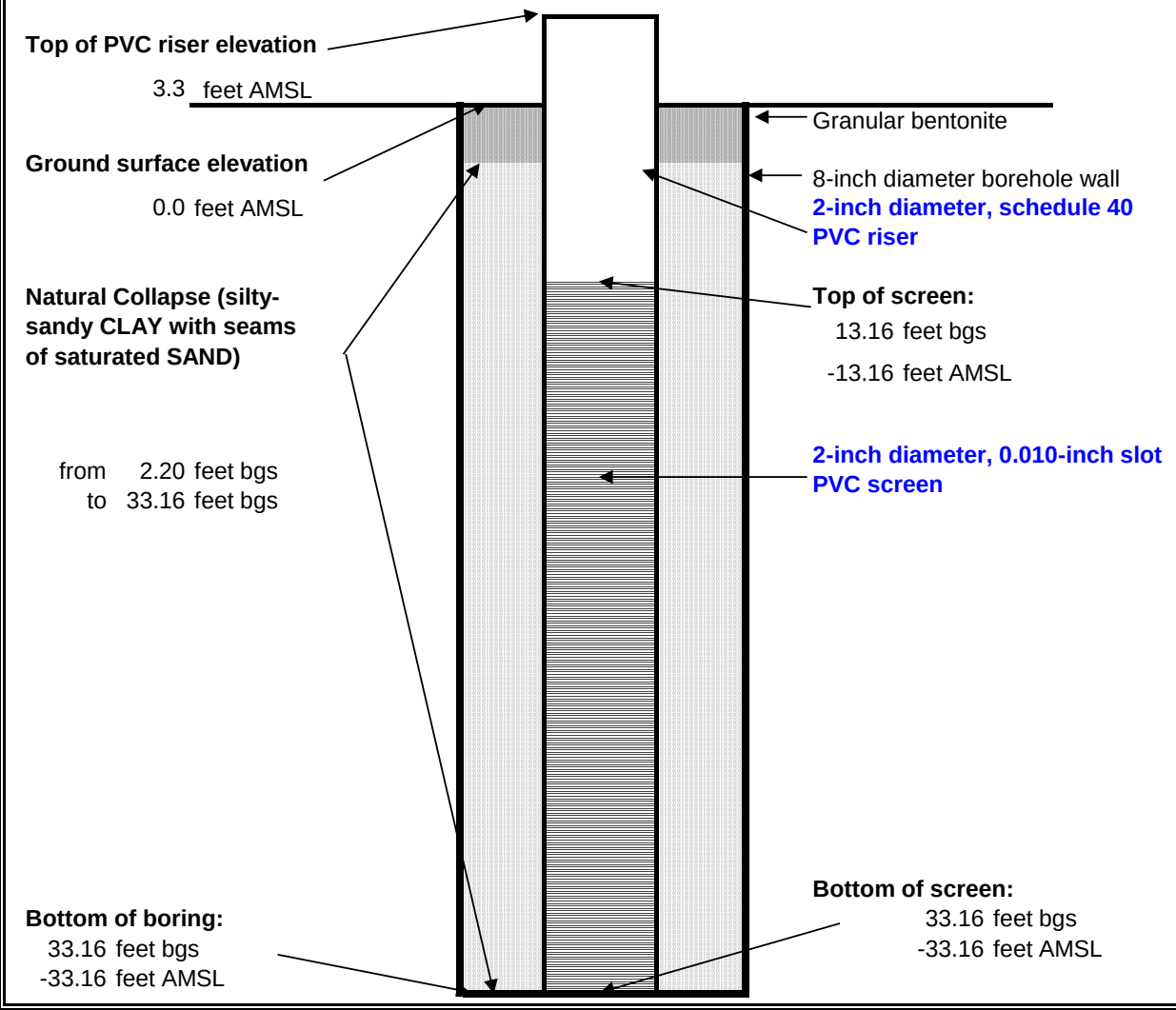
TOT DEPTH:	32.25	feet bgs	**LEGEND:**
TOC ELEV.:	182.670		Granular Bentonite
SCREEN FROM:	32.25	feet bgs	Natural Collapse
SCREEN TO:	12.25	feet bgs	
SCREEN TYPE:	2-inch PVC		
SCREEN SIZE:	0.020-inch slot		**NOTES:** AMSL: Above Mean Sea Level
CASING TYPE:	schedule 40 PVC		bgs: below ground surface
CASING SIZE:	2-inch diameter		
PUMP TYPE:	N/A		



WELL CONSTRUCTION DIAGRAM

SITE NAME:	Meritor, Grenada	DRILLING RIG:	Geoprobe 7822DT
		DRILL TYPE:	Direct Push
PROJECT #:	MERT-00010	START DATE:	8/21/2015
BORING ID:	IW10-3S	FINISH DATE:	8/21/2015
WELL ID:	IW10-3S	LOGGED BY:	NAH
COUNTY:	Grenada	WEATHER:	Overcast 76°F
TWP:	Grenada	GROUND ELEV.:	
DRILL CO.:	EFS	NORTHING:	
DRILLER:	J. Tillman	EASTING:	

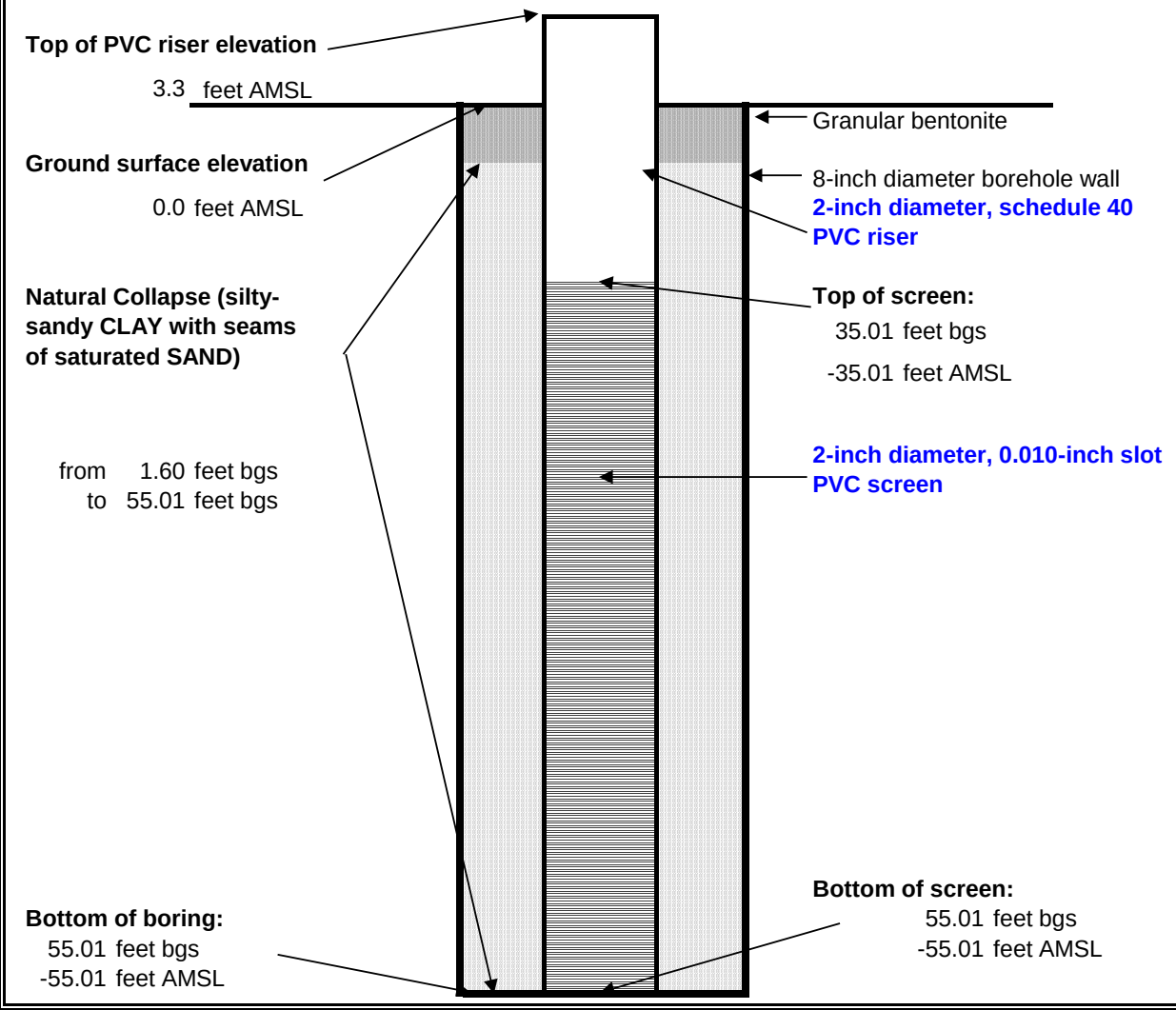
TOT DEPTH:	33.16	feet bgs	**LEGEND:**	
TOC ELEV.:	182.497		Granular Bentonite	
SCREEN FROM:	33.16	feet bgs	Natural Collapse	
SCREEN TO:	13.16	feet bgs		
SCREEN TYPE:	2-inch PVC			
SCREEN SIZE:	0.020-inch slot		**NOTES:** AMSL: Above Mean Sea Level	
CASING TYPE:	schedule 40 PVC		bgs: below ground surface	
CASING SIZE:	2-inch diameter			
PUMP TYPE:	N/A			



WELL CONSTRUCTION DIAGRAM

SITE NAME:	Meritor, Grenada	DRILLING RIG:	Geoprobe 7822DT
		DRILL TYPE:	Direct Push
PROJECT #:	MERT-00010	START DATE:	8/21/2015
BORING ID:	IW10-3D	FINISH DATE:	8/21/2015
WELL ID:	IW10-3D	LOGGED BY:	NAH
COUNTY:	Grenada	WEATHER:	Overcast 76°F
TWP:	Grenada	GROUND ELEV.:	
DRILL CO.:	EFS	NORTHING:	
DRILLER:	J. Tillman	EASTING:	

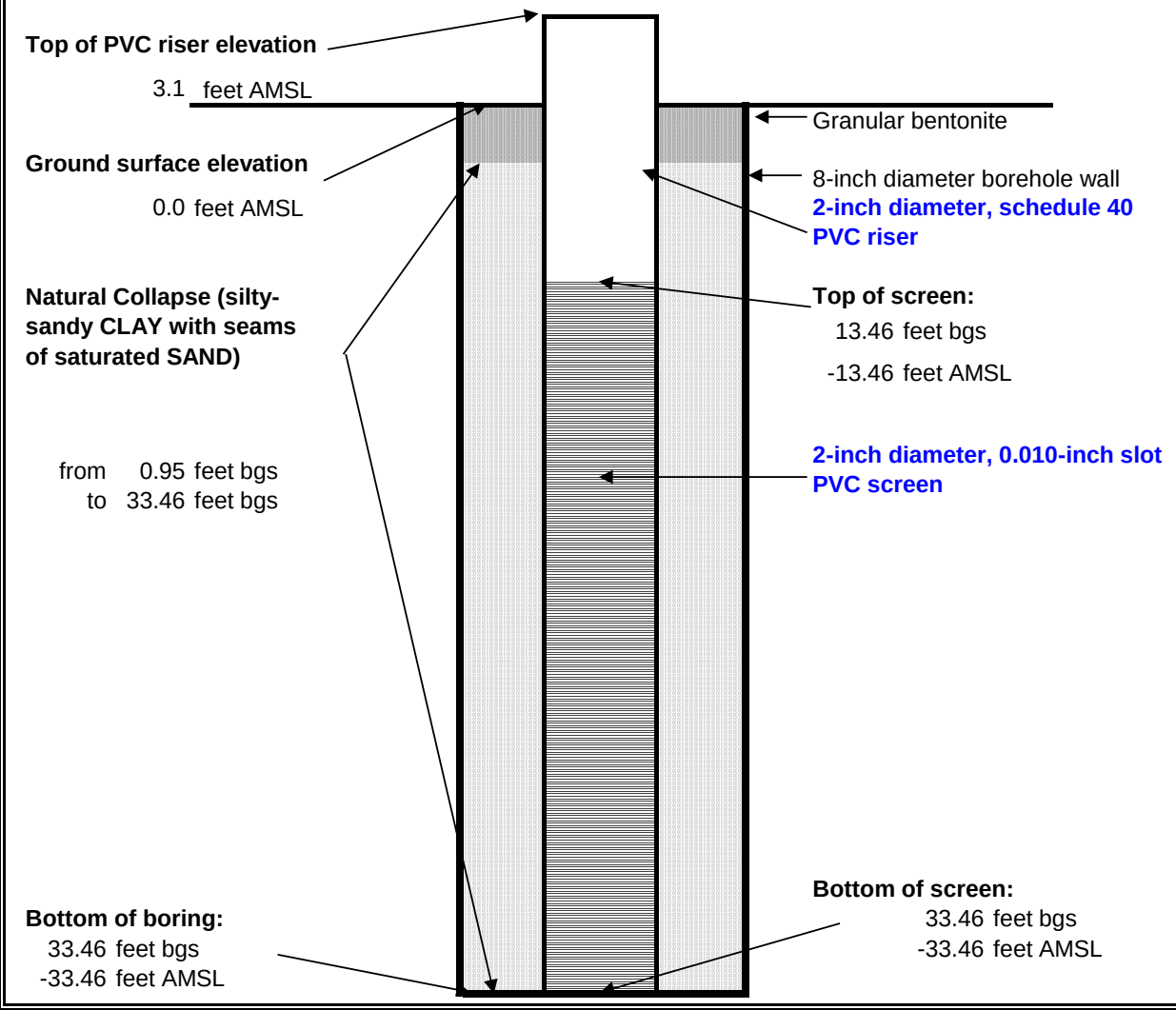
TOT DEPTH:	55.01	feet bgs	**LEGEND:**
TOC ELEV.:	182.499		Granular Bentonite
SCREEN FROM:	55.01	feet bgs	Natural Collapse
SCREEN TO:	35.01	feet bgs	
SCREEN TYPE:	2-inch PVC		
SCREEN SIZE:	0.020-inch slot		**NOTES:** AMSL: Above Mean Sea Level
CASING TYPE:	schedule 40 PVC		bgs: below ground surface
CASING SIZE:	2-inch diameter		
PUMP TYPE:	N/A		



WELL CONSTRUCTION DIAGRAM

SITE NAME:	Meritor, Grenada	DRILLING RIG:	Geoprobe 7822DT
		DRILL TYPE:	Direct Push
PROJECT #:	MERT-00010	START DATE:	8/21/2015
BORING ID:	IW10-4S	FINISH DATE:	8/21/2015
WELL ID:	IW10-4S	LOGGED BY:	NAH
COUNTY:	Grenada	WEATHER:	Overcast 76°F
TWP:	Grenada	GROUND ELEV.:	
DRILL CO.:	EFS	NORTHING:	
DRILLER:	J. Tillman	EASTING:	

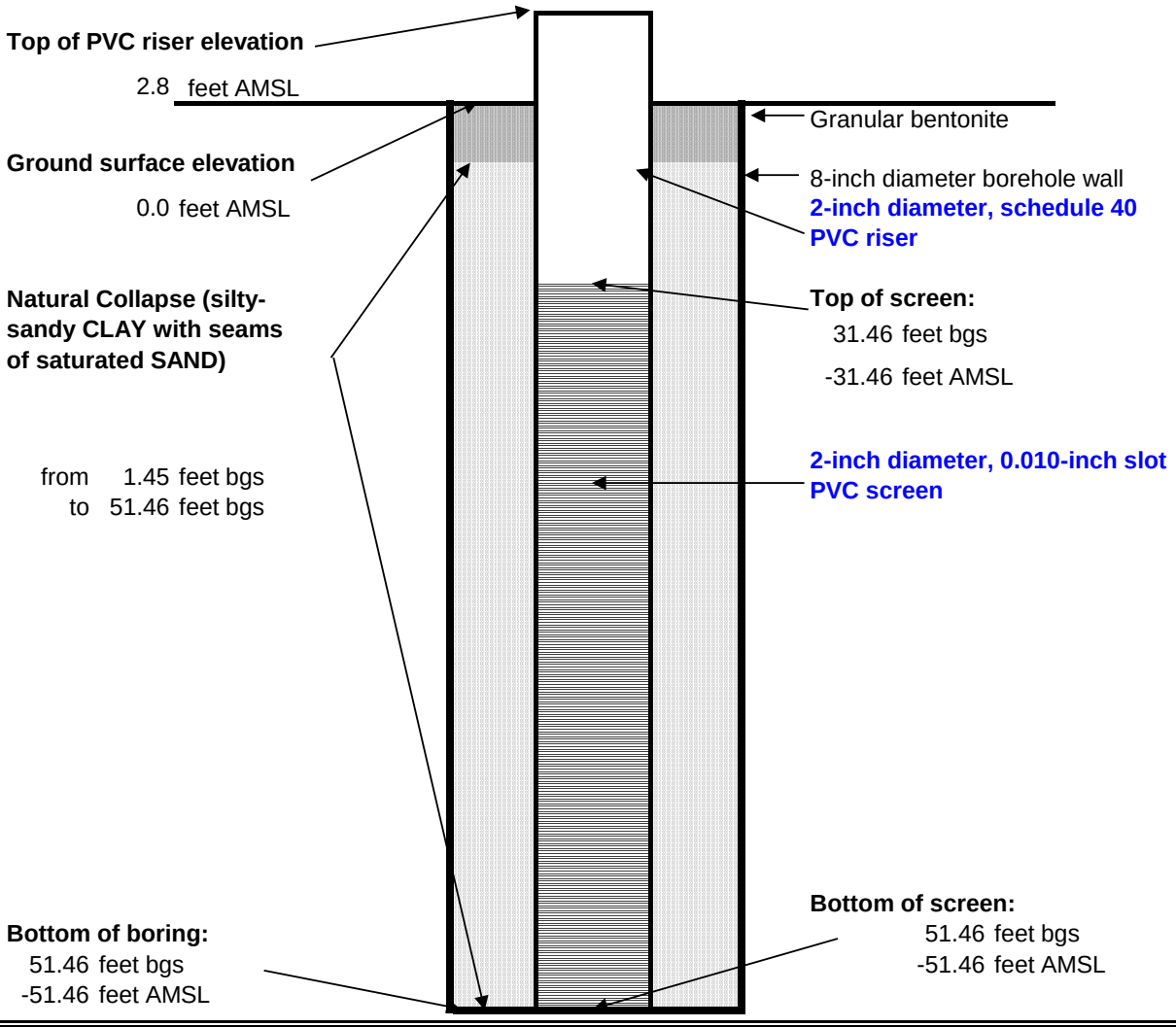
TOT DEPTH:	33.46	feet bgs	**LEGEND:**
TOC ELEV.:	182.477		Granular Bentonite
SCREEN FROM:	33.46	feet bgs	Natural Collapse
SCREEN TO:	13.46	feet bgs	
SCREEN TYPE:	2-inch PVC		
SCREEN SIZE:	0.020-inch slot		**NOTES:** AMSL: Above Mean Sea Level
CASING TYPE:	schedule 40 PVC		bgs: below ground surface
CASING SIZE:	2-inch diameter		
PUMP TYPE:	N/A		



WELL CONSTRUCTION DIAGRAM

SITE NAME:	Meritor, Grenada	DRILLING RIG:	Geoprobe 7822DT
		DRILL TYPE:	Direct Push
PROJECT #:	MERT-00010	START DATE:	8/21/2015
BORING ID:	IW10-4D	FINISH DATE:	8/21/2015
WELL ID:	IW10-4D	LOGGED BY:	NAH
COUNTY:	Grenada	WEATHER:	Overcast 76°F
TWP:	Grenada	GROUND ELEV.:	
DRILL CO.:	EFS	NORTHING:	
DRILLER:	J. Tillman	EASTING:	

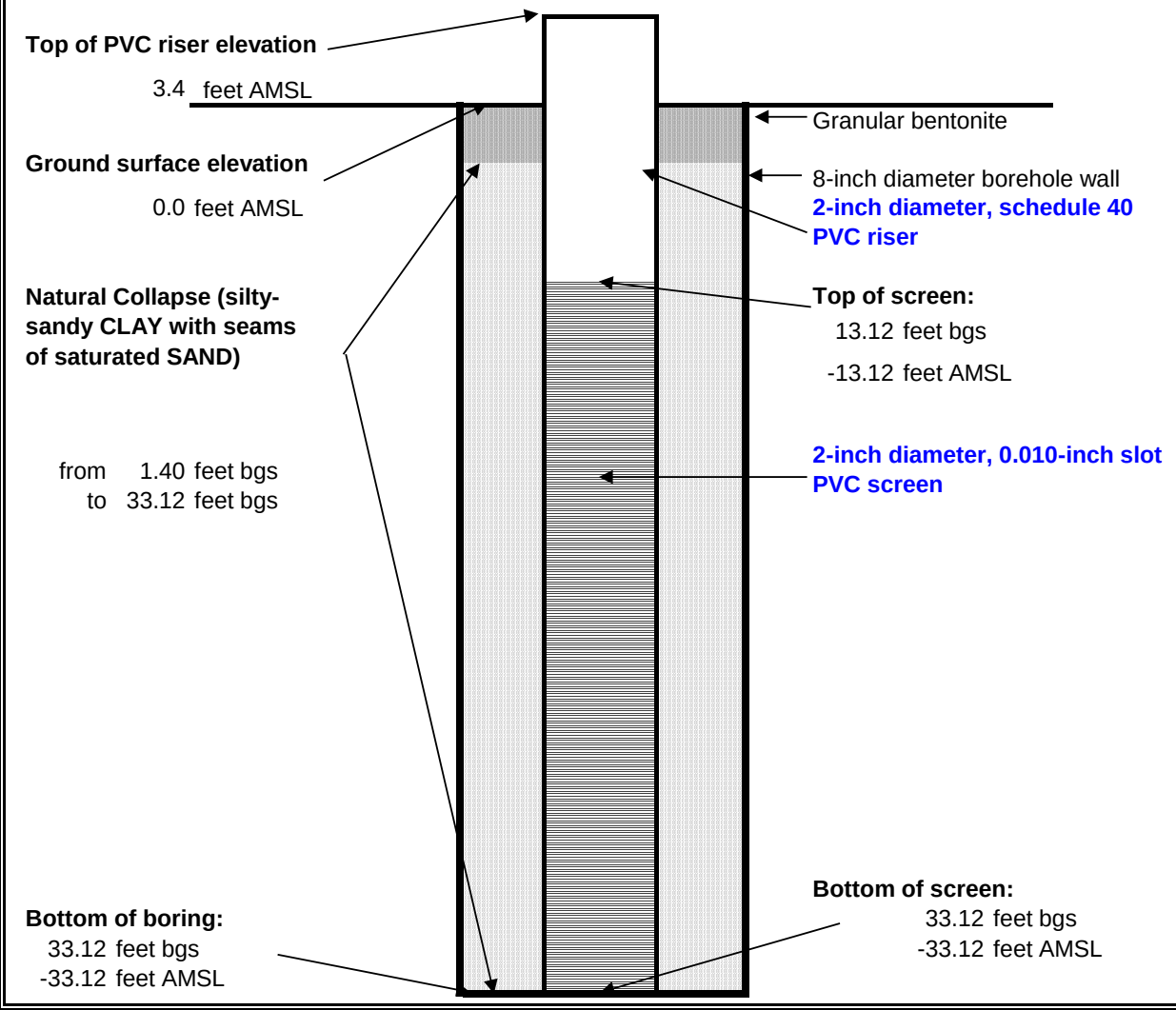
TOT DEPTH:	51.46	feet bgs	**LEGEND:**	
TOC ELEV.:	182.215		Granular Bentonite	
SCREEN FROM:	51.46	feet bgs	Natural Collapse	
SCREEN TO:	31.46	feet bgs		
SCREEN TYPE:	2-inch PVC			
SCREEN SIZE:	0.020-inch slot		**NOTES:** AMSL: Above Mean Sea Level	
CASING TYPE:	schedule 40 PVC		bgs: below ground surface	
CASING SIZE:	2-inch diameter			
PUMP TYPE:	N/A			



WELL CONSTRUCTION DIAGRAM

SITE NAME:	Meritor, Grenada	DRILLING RIG:	Geoprobe 7822DT
		DRILL TYPE:	Direct Push
PROJECT #:	MERT-00010	START DATE:	8/21/2015
BORING ID:	IW10-5S	FINISH DATE:	8/21/2015
WELL ID:	IW10-5S	LOGGED BY:	NAH
COUNTY:	Grenada	WEATHER:	Overcast 76°F
TWP:	Grenada	GROUND ELEV.:	
DRILL CO.:	EFS	NORTHING:	
DRILLER:	J. Tillman	EASTING:	

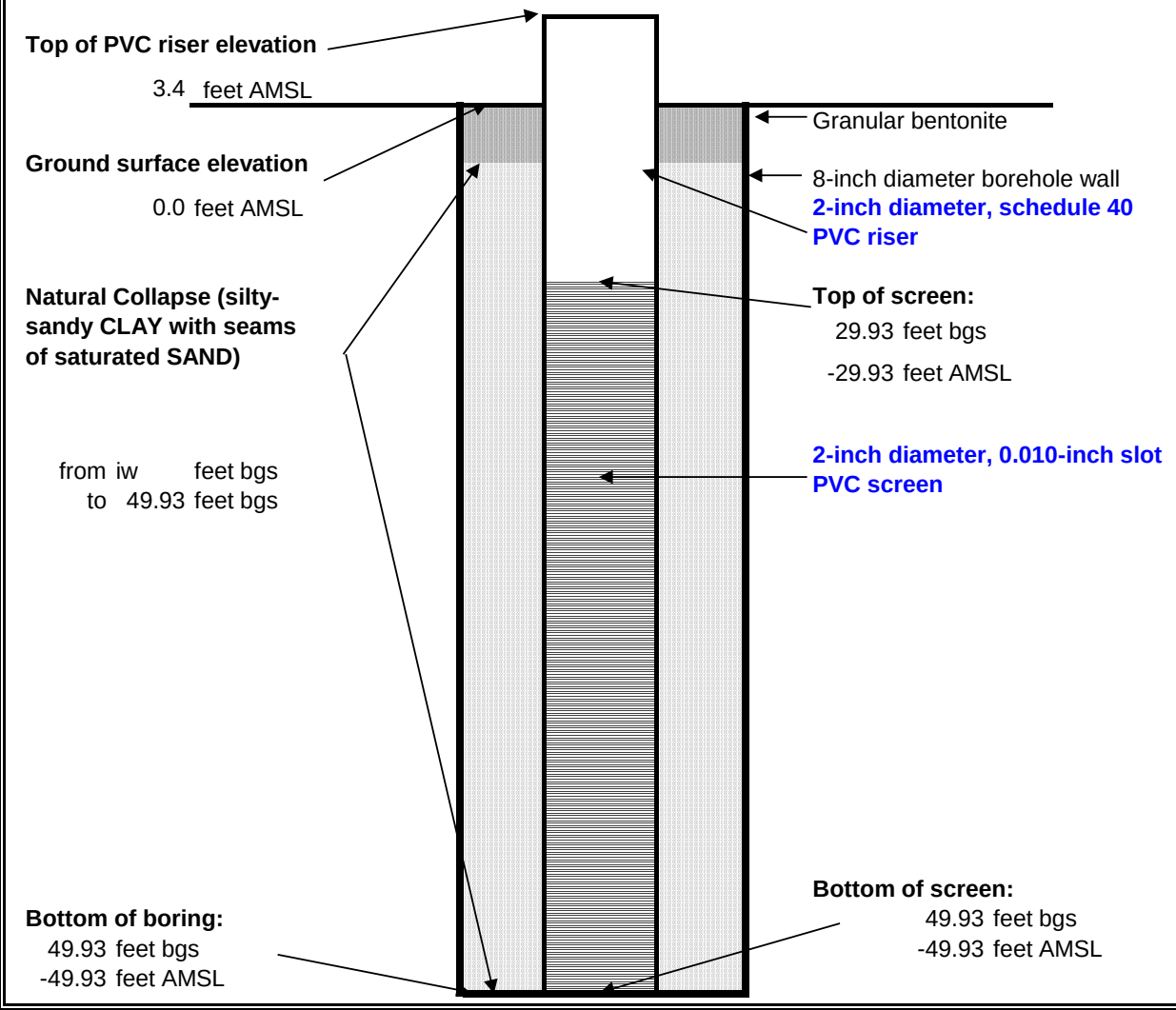
TOT DEPTH:	33.12	feet bgs	**LEGEND:**	
TOC ELEV.:	182.850		Granular Bentonite	
SCREEN FROM:	33.12	feet bgs	Natural Collapse	
SCREEN TO:	13.12	feet bgs		
SCREEN TYPE:	2-inch PVC			
SCREEN SIZE:	0.020-inch slot		**NOTES:** AMSL: Above Mean Sea Level	
CASING TYPE:	schedule 40 PVC		bgs: below ground surface	
CASING SIZE:	2-inch diameter			
PUMP TYPE:	N/A			



WELL CONSTRUCTION DIAGRAM

SITE NAME:	Meritor, Grenada	DRILLING RIG:	Geoprobe 7822DT
		DRILL TYPE:	Direct Push
PROJECT #:	MERT-00010	START DATE:	8/21/2015
BORING ID:	IW10-5D	FINISH DATE:	8/21/2015
WELL ID:	IW10-5D	LOGGED BY:	NAH
COUNTY:	Grenada	WEATHER:	Overcast 76°F
TWP:	Grenada	GROUND ELEV.:	
DRILL CO.:	EFS	NORTHING:	
DRILLER:	J. Tillman	EASTING:	

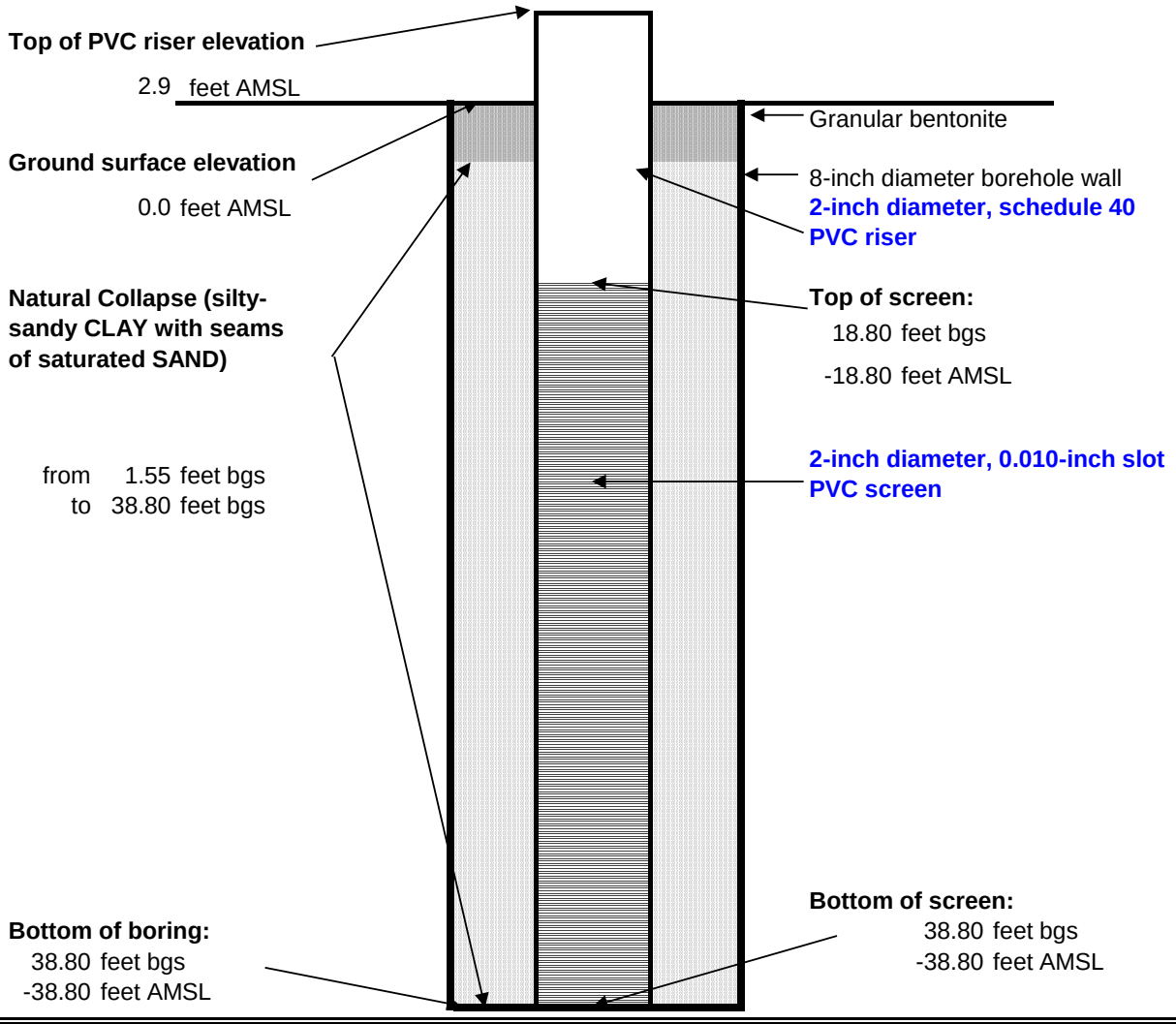
TOT DEPTH:	49.93	feet bgs	**LEGEND:**
TOC ELEV.:	182.943		Granular Bentonite
SCREEN FROM:	49.93	feet bgs	Natural Collapse
SCREEN TO:	29.93	feet bgs	
SCREEN TYPE:	2-inch PVC		
SCREEN SIZE:	0.020-inch slot		**NOTES:** AMSL: Above Mean Sea Level
CASING TYPE:	schedule 40 PVC		bgs: below ground surface
CASING SIZE:	2-inch diameter		
PUMP TYPE:	N/A		



WELL CONSTRUCTION DIAGRAM

SITE NAME:	Meritor, Grenada	DRILLING RIG:	Geoprobe 7822DT
		DRILL TYPE:	Direct Push
PROJECT #:	MERT-00010	START DATE:	8/21/2015
BORING ID:	IW10-5D1	FINISH DATE:	8/21/2015
WELL ID:	IW10-5D1	LOGGED BY:	NAH
COUNTY:	Grenada	WEATHER:	Overcast 76°F
TWP:	Grenada	GROUND ELEV.:	
DRILL CO.:	EFS	NORTHING:	
DRILLER:	J. Tillman	EASTING:	

TOT DEPTH:	38.80	feet bgs	**LEGEND:**	
TOC ELEV.:	182.415		Granular Bentonite	
SCREEN FROM:	38.80	feet bgs	Natural Collapse	
SCREEN TO:	18.80	feet bgs		
SCREEN TYPE:	2-inch PVC			
SCREEN SIZE:	0.020-inch slot		**NOTES:** AMSL: Above Mean Sea Level	
CASING TYPE:	schedule 40 PVC		bgs: below ground surface	
CASING SIZE:	2-inch diameter			
PUMP TYPE:	N/A			



Appendix B

SOP #2:
Control and Disposal of Investigative Derived Waste

Purpose/Application

The purpose of this procedure is to outline a procedure to personnel on how to handle and store waste derived for field investigations. Waste materials include drilling spoils, development water, decontamination fluids, disposable equipment, and personal protective equipment.

Recommended Equipment

- DOT-approved 55-gallon steel drum
- Personal protective equipment (nitrile gloves, safety goggles, etc.)

Procedures

Investigation derived wastes will be handled in accordance with the U.S. EPA Memorandum Guide to Management of Investigative-Derived Wastes (Publication 9345.3-03FS) that is attached to this SOP. A summary of the procedures to be followed are outlined below.

As borings are advanced, spillage of potentially contaminated soils and water will be minimized and these materials will be containerized (e.g. in U.S. Department of Transportation (DOT)-approved 55-gallon steel drums). Soils and water will be drummed separately. The contents of each drum will be identified on the drum exterior using weather-resistant labels or paint.

Depending on the levels of personal protection used during the field investigation, some disposable personal protective equipment (PPE) and decontamination fluids will be generated. Attempts will be made to remove surface contamination so that PPE (e.g., Tyvek coveralls, gloves, and other disposable items) may be disposed of as ordinary solid waste. If contamination is suspected, these materials will also be containerized in UN-approved 55-gallon steel drums. Decontamination fluids will be disposed of with drilling fluids generated at the site. Decontamination fluids containing solvents or nitric acid will be containerized separately from drilling fluids.

Containerized materials will be transported to, and staged at, a designated location. T&M personnel will maintain a log of the containers and their contents. Handling, transportation, and disposal of these materials will be in accordance with requirements of applicable federal, state, and local regulations. Nonhazardous materials will be contained and disposed as solid waste.

References

EPA, 1992. Guide to Management of Investigative-Derived Wastes. U.S. EPA Office of Solid Waste and Emergency Response, Hazardous Site Control Division OS-220W. 9345.3-03FS.

Attachment A to SOP #2:

Guide to Management of Investigative-Derived Wastes (U.S. EPA Memorandum, January 15, 1992)

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

JAN 15 1992

9345.3-03FS
OFFICE OF
SOLID WASTE AND EMERGENCY RESPONSE

MEMORANDUM

SUBJECT: Guide to Management of Investigation-Derived Wastes

FROM: Henry L. Longest II, Director /s/
Office of Emergency and Remedial Response

TO: Waste Management Division Director
Regions I, IV, V, VII, VIII
Emergency and Remedial Response Division Director
Region II
Hazardous Waste Management Division Director
Regions III, VI
Toxics and Waste Management Division Director
Region IX
Hazardous Waste Division Director
Region X

The purpose of this memorandum is to distribute the final fact sheet entitled "Guide to Management of Investigation-Derived Wastes." This fact sheet was circulated for Regional review and comment in November 1991; comments have been incorporated into this final version.

Additional copies of the fact sheet can be obtained from EPA's Superfund Docket (FTS 260-3046). If you have any questions regarding the information in the fact sheet, please call your HSCD Regional Coordinator, or Andrea McLaughlin at FTS 678-8365 or 703-308-8365.

Enclosure

cc: Superfund Branch Chiefs, Regions I-X
Superfund Section Chiefs, Regions I-X

United States Environmental Protection Agency | Office of Solid Waste and Emergency Response | Publication: 9345.3-03FS January 1992

Guide to Management of Investigation–Derived Wastes

Office of Emergency and Remedial Response
Hazardous Site Control Division OS-220W

Quick Reference Fact Sheet

CERCLA field investigation activities (e.g., remedial investigation/feasibility studies and remedial designs) may result in the generation of waste materials that may pose a risk to human health and the environment. These investigation-derived wastes (IDW) may include drilling muds, cuttings, and purge water from test pit and well installation; purge water, soil, and other materials from collection of samples; residues (e.g., ash, spent carbon, well development purge water) from testing of treatment technologies and pump and treat systems; contaminated personal protective equipment (PPE); and solutions (aqueous or otherwise) used to decontaminate non-disposable protective clothing and equipment. The management of IDW must ensure protection of human health and the environment and comply with (or waive) regulatory requirements that are applicable or relevant and appropriate requirements (ARAR). This fact sheet presents an overview of possible IDW management options, discusses the protectiveness requirements and ARARs associated with these options, and outlines general objectives established for IDW management under Superfund.[1]

The general options for managing IDW (see **Highlight 1**) are collection and either (1) immediate disposal or (2) some type of interim management. Interim management may include storage or other temporary. As dismissed below, the specific option selected will depend on the type of waste produced, its relative threat to human health and the environment, and other site-specific conditions.

IDW MANAGEMENT REQUIREMENTS

When managing IDW, site managers are required to choose an option that: (1) is protective of human health and the environment and (2) complies with (or waives) ARARs, as described below.

Protectiveness

In determining if a particular management/disposal option is protective, site managers should consider the following:

- The contaminants, their concentrations, and total Volume of IDW;
- Media potentially affected (e.g., ground water, soil) under management options;
- Location of the nearest population(s) and the likelihood and/or degree of site access;
- Potential exposures to workers; and
- Potential for environmental impacts.

As a general rule, it will be necessary to use best professional judgment, in light of the site-specific conditions, to determine whether an option is protective of human health and the environment. For example, a site manager may determine that storing IDW temporary until the final action or returning IDW to its source is protective, based on knowledge that the material poses low risk and/or that the final action will address any risks posed by the wastes and there will be no unacceptable risks in the interim.

Alternatively, if the site includes or is near residential areas, the site is unsecured, and/or contaminants appear to be present at unacceptable levels, it may not be protective to return excavated soil to the source. Storing IDW in containers in an on-site, secure location, or sending it off site immediately may be more appropriate.

Site managers also need to consider the potential effects of IDW management-related activities on environmental media. For example, pouring contaminated purge water on the ground around a well may not be prudent, because such an action could mobilize any hazardous constituents present in the soil or introduce contaminants into clean soil.

Compliance with ARARs

Remedial Investigation/Feasibility Study (RI/FS) and Remedial Design (RD) actions must comply with ARARs "to the extent practicable, considering the exigencies of the situation" (NCP, 55 FR 8756, emphasis added); therefore, it generally will not be necessary to obtain a waiver if an ARAR cannot be attained during these actions. If a site manager determines that, based on site-specific factors, compliance with an ARAR is practicable but an ARAR waiver is warranted for an RI/FS or RD action, an interim action waiver may be available if the final remedy will attain the ARAR. An action memorandum should be prepared for the waiver, the state given an opportunity to comment, and the decision document placed in the administrative record.

[1] Management of treatability study and treatment pilot wastes is discussed in Guide for Conducting Treatability Studies Under CERCLA. Interim Final, December 1989, EPA/540/2-89/058. Information on management of IDW generated during Preliminary Assessments and Site Investigations is provided in Management of Investigation-Derived Waste During Site Investigations, May 1990, EPA/540/G-91/009.

Highlight 1: IDW MANAGEMENT OPTIONS

Type of IDW	Generation Processes*	Management Options
Soil	• Well/test pit installation • Borehole drilling • Soil sampling	• Return to boring, pit, or source immediately after generation • Spread around boring, pit, or source within the AOC+ • Consolidate in a pit (within the AOC) • Send to on-site TDU+ • Send to TDU off site immediately • Store for future treatment and/or disposal
Sludges/sediment	• Sludge pit/sediment sampling	• Return to boring, pit, or source immediately after generation • Send to on-site TDU • Send to TDU off site immediately • Store for future treatment and/or disposal
Aqueous liquids (ground water, surface water, drilling fluids, other wastewaters)	• Well installation/development • Well purging during sampling • Ground water discharge during pump tests • Surface water sampling	• Discharge to surface water • Pour onto ground close to well (non-hazardous waste) • Send to on-site TDU • Send to off-site commercial treatment unit • Send to POTW+ • Store for future treatment and/or disposal
Decontamination fluids	• Decontamination of PPE+ and equipment	• Send to on-site TDU • Evaporate (for small amounts of low contamination organic fluids) • Send to TDU off site immediately • Store for future treatment and/or disposal
Disposable PPE	• Sampling procedures or other on-site activities	• Send to on-site TDU • Place in on-site industrial dumpster • Send to TDU off site immediately • Store for future treatment and/or disposal

• The generation processes listed here are provided as examples. IDW may also be produced as a result of activities not listed here.

+ AOC: Area of Contamination (AOCs at a site may not yet have been identified at the time of the RI/FS); TDU: Treatment/disposal Unit; POTW: Publicly Owned Treatment Works; PPE: Personal Protective Equipment

Potential ARARs for IDW at CERCLA sites include regulations under the Resource Conservation and Recovery Act (RCRA) (including both Federal and State underground injection control (UIC) regulations), the Clean Water Act (CWA), the Clean Air Act (CAA), the Toxic Substances Control Act (TSCA), and other State environmental laws. How these various requirements may direct or influence IDW management decisions is described below.

Resource Conservation and Recovery Act (RCRA). Certain sections of the RCRA Subtitle C hazardous waste regulations (e.g., land disposal restrictions and storage restrictions) may be ARARs for IDW should RCRA hazardous waste be identified at a site. (Note that RCRA may be relevant and appropriate even if the IDW is not a RCRA hazardous waste.) A waste is hazardous under RCRA if it is listed as such in 40 CFR 261.31 - 261.33 or if it exhibits one of four characteristics: ignitability, corrosivity, reactivity, or toxicity.

Site managers should not assume that a waste considered to pose a potential risk at a CERCLA site is a listed or characteristic RCRA hazardous waste. Until there is positive evidence (records, test results, other knowledge of waste properties) that the IDW is a RCRA hazardous waste, site managers should manage it in a protective manner (but not necessarily in accordance with Subtitle C requirements). Business records or facility processes should be examined to determine whether RCRA listed wastes were generated and are present in the IDW. For characteristic wastes, site managers should rely on testing results or on knowledge of the material's properties. If best professional judgment and available information indicate that, for protectiveness reasons (or because managed as a "hazardous waste" management in accordance with Subtitle C requirements is prudent, regardless of whether it is known to be a RCRA waste.

If aqueous liquid IDW is considered a RCRA hazardous waste, the site manager should determine whether the Domestic Sewage Exclusion (DSE) applies to the discharge of that IDW to a POTW. The RCRA DSE exempts domestic sewage and any mixture of domestic sewage and other wastes that passes through a sewer system to a POTW for treatment from classification as a solid waste and, therefore, as a RCRA hazardous waste (40 CFR 261.4).

- Land Disposal Restrictions

If IDW is determined to be a RCRA hazardous waste and subject to the land disposal restrictions (LDRs), "land disposal" of the IDW will be prohibited unless specified treatment standards are met (see Superfund LDR Guides #5 and #7, Determining When LDRs Are Applicable to CERCLA Response Actions and Determining When LDRs Are Relevant and Appropriate to CERCLA Response Actions, OSWER Directive 9347.3-05FS and 9347.3-08FS, June 1989 and December 1989 and the NCP, 55 FR 8759, March 8, 1990). "Land disposal" occurs when wastes from different AOCs are consolidated into one AOC; when wastes are moved outside an AOC (for treatment or storage) and returned to the same or a different AOC; or when wastes are excavated, placed in a separate hazardous waste management unit such as an incinerator or tank within the AOC, and then redeposited into the AOC.

Storing IDW in a container ("a portable device in which a material is stored, transported, treated, disposed of, or otherwise handled" (40 CFR 260.10)) within the AOC and then returning it to its source, however, is allowable without meeting the specified LDR treatment standards. Under the definition of "hazardous waste management until" (40 CFR 260.10), EPA states that "a container alone does not constitute a unit; the unit includes the containers and the land or pad upon which they are placed." Therefore, returning IDW that has been stored in containers (not tanks or other RCRA-regulated units) within the AOC to its source does not constitute land disposal, as long as containers are not managed in such a manner as to constitute a RCRA storage unit as defined in 40 CFR 260.10. In addition, sampling and direct replacement of wastes within an AOC do not constitute land disposal.

- Storage

Subtitle C outlines the storage requirements for RCRA hazardous wastes. Under RCRA, "storage" is defined as "the holding of hazardous waste for a temporary period, at the end of which the hazardous waste is treated, disposed of, or stored elsewhere" (40 CFR 260.10).

On-site Superfund actions are only required to comply with the substantive standards of other laws (see 40 CFR 300.5, definitions of applicable or relevant and appropriate requirements). Superfund sites are also exempt from permit requirements under CERCLA §121(e). Therefore, site managers are not required to comply with administrative requirements triggered by RCRA storage deadlines (e.g., contingency planning, inspections, recordkeeping). Generally equivalent administrative activities are undertaken at Superfund sites, however, under existing Superfund management practices.

Site managers storing known RCRA hazardous waste must comply with the substantive, technical requirements of 40 CFR Parts 264 and 265 Subparts I (containers), J (tanks), and L (waste piles), to the extent practicable. (See **Highlight 2** for a summary of these technical requirements for each type of unit). In addition, the ground-water monitoring requirements of 40 CFR Parts 264 and 265 Subpart F are potential ARARs, and to the extent they are determined to be ARARs at a site, they should be attained to the extent practicable (or waived). (In many cases, ground-water monitoring conducted during the RI/FS will provide protection equivalent to the Subpart F requirements.)

[NOTE: Under the LDRs, restricted RCRA hazardous waste may not be stored at a site unless the storage is solely for the purpose of accumulating sufficient quantities of the waste to facilitate proper disposal, treatment, or recovery (see 40 CFR 268.50). Generally, storing IDW until a final disposal option is selected in a Record of Decision (ROD) and implemented during the remedial action is allowable storage under the RCRA LDR storage prohibition.]

- Recordkeeping and Manifesting

If hazardous wastes are sent off site, the site manager must comply with both administrative and substantive elements of the RCRA generator requirements of 40 CFR Part 262 and LDR notification and certification requirements of Part 268. (For example, a site manager must prepare an LDR notification and certification when restricted wastes are sent off site to a land disposal facility.) These standards include requirements such as manifests for shipping waste that list all hazardous waste listings and characteristics applicable to the waste (see 40 CFR 262.11), packaging and transport requirements, and recordkeeping requirements.

If the LDRs are applicable, the following information should be collected and available before the removal of wastes to an off-site disposal facility: EPA hazardous waste number, LDR treatment

Highlight 2:
EXAMPLES OF RCRA TECHNICAL STORAGE REQUIREMENTS*

RCRA storage requirements, applicable to both less-than-90-days generators and permitted or interim status storage facilities, may include the following substantive requirements:

Containers 40 CFR 264 Subpart I and 265 Subpart I

- Containers must be in good condition
- Wastes must be compatible with container
- Container must be closed during storage
- Container storage areas must have a containment system that can contain 10 percent of the volume of containers or of the largest container
- Spilled or leaked waste must be removed from the collection area as necessary to prevent overflow

Tanks 40 CFR 264 Subpart J and 265 Subpart J

- Tanks must have a secondary containment system that includes a liner, a vault, a double-walled tank, or an equivalent device (applies only to certain tanks)

Waste Piles 40 CFR 264 Subpart L and 265 Subpart L

- Waste piles must have a liner and a leachate collection and removal system
- Owners/operators must have a run-on control system to prevent flow onto the active portion of the pile during peak discharge from at least a 25-year storm
- Owners/operators must have a run-off management system to collect and control at least the water volume resulting from a 24-hour, 25-year storm

- This is a partial list of substantive requirements. For more detail, see 40 CFR Part 264 and 265.

standards, manifest number for the waste shipment, and waste analysis data.

- Underground Injection Control (UIC) Program

Under the UIC regulations, RCRA hazardous wastes may be injected into Class I permitted wells. In some cases, hazardous liquids, such as extracted ground water from pump and treat operations, may be injected into a Class IV UIC well. For example, ground water contaminated with RCRA hazardous wastes may be injected into Class IV permitted wells if it is part of a CERCLA response action or a RCRA corrective action and if it has been treated to "substantially reduce hazardous constituents prior to such injection..." (RCRA § 3020(b)). (See Applicability of Land Disposal Restrictions to RCRA and CERCLA Ground Water Treatment Reinjection, OSWER Directive #9234,1-06, December 1989.)

- Non-RCRA Hazardous Wastes

Some non-RCRA hazardous waste may be subject to management requirements under Subtitle D of RCRA as solid wastes. Subtitle D regulates disposal of solid waste in facilities such as municipal landfills. Therefore, non-RCRA hazardous IDW, such as decontaminated PPE or equipment, may need to be disposed of in a Subtitle D facility (depending on State requirements).

Clean Water Act (CWA). Discharges of aqueous IDW to surface water and publicly owned treatment works (POTWs) may be required to comply with CWA Federal, State, and local requirements. Requirements to be met may include water quality criteria, pre-treatment standards, State water quality standards, and NPDES permit conditions. Direct discharges to on-site waters are subject only to substantive requirements, while discharges to POTWs and other off-site discharges must comply with both substantive and administrative CWA requirements (including permitting requirements). (See Guide to Discharging CERCLA Aqueous Wastes to POTWs, June 1991 and CERCLA Compliance with the CWA and SDWA, #9234.2-06FS, January 1991.)

Toxic Substances Control Act (TSCA). If IDW contains PCBs, TSCA treatment and/or disposal requirements may apply during its management. TSCA requirements regulate the disposal of material contaminated with PCBs at concentrations of 50 ppm or greater as found on site (i.e., based on sample analysis and not the PCB concentration of the source material {e.g., transformer fluid}). (See PCB Guidance Manual, EPA/540/G-90/007, August 1990.) In addition, TSCA storage requirements may apply that limit the time that PCBs may be stored to one year. Furthermore, if PCB materials are mixed with a RCRA hazardous waste, they may be regulated by the LDR California list prohibitions. (See RCRA sections 3004(d)(2)(D) and (E).)

Department of Transportation (DOT) requirements. Where IDW will be disposed of off site or transported on public roads to a site, DOT requirements for containerizing, labeling, and transporting hazardous materials and substances may apply.

State requirements. Promulgated State regulations that are legally enforceable, timely identified, and more stringent than Federal regulations may be potential ARARs for IDW managed on site. Substantive requirements of State law that may be ARARs for IDW management include State water quality standards, direct discharge limits, and RCRA requirements (including underground injection control regulations) promulgated in a State with an authorized RCRA hazardous waste management program (as well as programs authorized by State laws). Off-site, substantive and administrative requirements of State law may apply.

Off-Site Policy. In addition to complying with requirements of Federal and State laws, all off-site disposal of wastes must comply with CERCLA section 121(d)(3) and the CERCLA Off-Site Policy (OSWER Directive No. 9834.11 (November 13, 1987)). The Off-Site Policy establishes criteria for selecting an appropriate treatment, storage, or disposal facility (TSDF), including release criteria for all facilities that receive wastes from CERCLA-authorized or funded response actions. In addition, receiving facilities must be in compliance with all "applicable laws."

Before shipping wastes off site, approval should be obtained for the proposed disposal facility from EPA's Regional Off-Site Policy Coordinator. In addition, EPA has adopted a policy for Superfund wastes shipped out of State that written notification should be provided to receiving States (OSWER Directive 9330.2-07, September 14, 1989).

GENERAL OBJECTIVES FOR IDW MANAGEMENT

In addition to the two requirements of protectiveness and compliance with ARARs to the extent practicable (on site) or

compliance with applicable law (off site), EPA has identified two general objectives that Superfund site managers should consider when managing IDW: (1) minimization of IDW generation; and (2) management of IDW consistent with the final remedy for the site. The extent to which these objectives can be achieved is highly dependent on site-specific circumstances.

IDW Minimization

Site managers should strive to minimize the generation of IDW to reduce the need for special storage or disposal requirements that may result in substantial additional costs yet provide little or no reduction in site risks relative to the final remedial action. Generation of IDW can be minimized through proper planning of all remedial activities that may generate IDW, as well as through use of screening information from the site inspection. The potential problems of managing IDW should be a factor in choosing an investigative method. Site managers may wish to consider techniques such as replacing solvent-based cleaners with aqueous-based cleaners for decontamination of equipment, reuse of equipment (where it can be decontaminated), limitation of traffic between clean and hot zones, and drilling methods and sampling techniques that generate little waste. Examples of such techniques include using gridding techniques to minimize the number of test pits or using soil borings instead of test pits. Alternative drilling and subsurface sampling methods may include the use of small diameter boreholes, as well as borehole testing methods such as a core penetrometer instead of coring. Site managers should also be careful to keep hazardous wastes separate from nonhazardous wastes.

Management Consistent with Final Remedy

Most IDW (with the exception of non-indigenous IDW) generated during the course of an investigation are intrinsic elements of the site. If possible, IDW should be considered part of the site and should be managed with other wastes from the site, consistent with the final remedy. This will avoid the need for separate treatment and/or disposal arrangements.

Because early planning or IDW management can prevent unnecessary costs and the use of treatment or disposal capacity, IDW management should be considered as early as possible during the remedial process. A key decision to be made is whether the waste will best be treated/disposed of immediately or addressed with the final remedy. If addressed with the final remedy, IDW volumes should be considered in the FS. In addition, when IDW is stored on site, it should be managed as part of the first remedial action/operable unit that addresses the affected media.

SELECTION OF IDW DISPOSAL OPTIONS

The following sections present the Agency's presumptions for IDW management that have been established based on the above considerations. The actual option selected should be based upon best professional judgment and should take into account the following factors:

- The type and quantity of IDW generated (sludge/soil, aqueous liquid, non-indigenous IDW);
- Risk posed by managing the IDW on site (e.g., based on site access controls, contaminant concentrations);
- Compliance with ARARs, to the extent practicable (on site);
- IDW minimization; and
- Whether the final remedy is anticipated to be an off-site or on-site remedy (or this information is unknown) and whether IDW can be managed consistent with the final remedy.

Off-site Final Remedies

If a site manager believes that the final remedy will involve off-site disposal of wastes, EPA's presumption is to manage the IDW as part of the remedial action addressing the waste/medium. Thus, until the final action, the IDW may be stored (e.g., drummed, covered waste pile) or returned to its source. However, the management option selected should also take into account any protectiveness concerns, ARARs, and other relevant site-specific factors (e.g., weather, storage space, and public concern/perceptions).

There are several potential reasons why it may be advisable to store IDW until the final action. First, because wastes at the site will be shipped off site eventually, returning IDW (especially sludges and soil) to its source would require that it be excavated again. Thus, site managers may consider it practical to containerize IDW as soon as it is generated. Second, storing IDW in containers may be more protective than returning it to its source. Third, because off-site actions may trigger such requirements as the LDRs, temporary storage will eliminate the need to meet these additional requirements until the final remedy.

In some cases, circumstances may lead site managers to choose to return the IDW to its source. This may be appropriate if it is determined that returning IDW to the source is protective and that storage at the site is not possible or practicable (i.e., given State or community concerns). In other cases, long-term storage may not be protective, and immediate off-site disposal may be a better option.

> **Examples:** A site involves volatile organic RCRA hazardous wastes that will likely be sent off site for final treatment and disposal. Site conditions are such that temporary storage of IDW is considered protective until the remedial action begins. Because off-site disposal will trigger RCRA disposal requirements such as the LDRs and immediate containerization would be more protective than redepositing into the source area at the time of sampling, the site manager decides to containerize the IDW (and comply with RCRA substantive technical tank and container standards) until the final action is initiated.

On-site Final Remedies (or Final Management is as Unknown Location)

When final management of wastes is likely to occur on site, the management presumptions vary depending on the type of IDW produced.

Sludge/soil

Generally, the Agency expects sludge or soil IDW will be returned to its source if short-term protectiveness is not an issue. The reason behind this presumption is that IDW that may pose a risk to human health and the environment in the long term will be addressed by the final action. Storage of RCRA hazardous IDW in containers with the AOC prior to returning it to the source will not trigger the LDRs, as long as the containers are not managed in such a way as to constitute a RCRA storage unit as

defined in 40 CFR 260.10. Therefore, it may be possible to store IDW temporarily before redisposing of it. However, EPA believes that, in many cases, returning sludges and soils to their source immediately will be protective and will avoid potentially increased costs and requirements associated with storage. Site-specific decisions on how to manage sludge and soil IDW may ultimately vary from the presumption based on protectiveness, ARARs, and/or community concerns.

Example 1: The soil at a site contains wastes that are expected to be stabilized on site during the final remedial action. The site manager determines that sending soil IDW off site is not cost-effective, because off-site disposal would involve testing and transport costs for a relatively small amount of waste. Instead, knowing that the site is secured and that redisposing the waste at the source will not increase site risk or violate ARARs, the site manager decides to return soil IDW to the source area from which it originated.

Example 2: A site manager determines that returning highly contaminated PCB wastes to the ground at a site is not protective because of the potential risks associated with the material; instead, the site manager chooses to drum the waste and send it off site (in compliance with TSCA). (Off-site disposal may occur immediately or at a later date.)

Example 3: Soil IDW contaminated with a RCRA hazardous waste is generated from a soil boring. The site manager decides to put the IDW back into the borehole immediately after generation, but ensures that site risks will not be increased (e.g., the contaminated soil will not be replaced at a greater depth than where it was originally so that it will not contaminate "clean" areas) and that the contamination will be addressed in the final remedy.

Aqueous liquids

EPA has not established a presumption for the management of aqueous liquid IDW (e.g., ground water). Site managers should determine the most appropriate disposal option for aqueous liquids on a site-specific basis. Parameters to consider, especially in making the protectiveness decision, include the volume of IDW, the contaminants present in the ground water, the presence of contaminants in the soil at the site, whether the ground or surface water is a drinking water supply, and whether the ground-water plume is contained or moving. Special disposal/handling may be needed for drilling fluids because they may contain significant solid components. Examples of aqueous liquid management decisions considering these factors are presented in the following box.

Example 1: A site manager has large volumes of ground water IDW and does not know if it is contaminated. Pouring this IDW on the ground would not be protective, because it may contaminate previously uncontaminated soil or may mobilize contaminants that are present in the soil. Therefore, the site manager stores the water in a mobile tank until a determination is made as to whether the water and soil are contaminated or until the final action.

Example 2: IDW is generated from the sampling of background, upgradient wells. Because there are no community concerns or evidence of any soil contamination from other sources, the site manager decides to pour this presumably uncontaminated IDW on the ground around the well.

Example 3: Purge water from a deep aquifer is known to be contaminated with a RCRA hazardous waste. At this site, if this water were poured on the ground, it could contaminate a previously uncontaminated shallow aquifer that is a potential drinking water source and would have to comply with the LDRs. The site manager decides to containerize the water within the AOC and store it until the final remedy.

Non-indigenous IDW

Non-indigenous IDW (e.g., sampling materials, disposable PPE, decontamination fluids) should be stored until the final remedy or disposed of immediately. If contaminated, such waste may not be disposed of onto the ground because such an action would add contamination that was not present when activities began at the site (e.g., solvents used for decontamination). If non-indigenous IDW is contaminated with RCRA hazardous waste, it must be managed in accordance with RCRA Subtitle C requirements. Otherwise, site managers may generally dispose of it in an on-site dumpster (for PPE).

Example 1: Disposable PPE (e.g., gloves, shoe covers) becomes contaminated with RCRA hazardous waste during the field investigation. The site manager containerizes and disposes of this IDW in compliance with RCRA Subtitle C requirements.

Example 2: Disposable equipment becomes contaminated during a field investigation. The site manager decontaminates them and sends them to a Subtitle D facility.

COMMUNITY CONCERNS

Residents of communities near a CERCLA site, local governments, or States may have concerns about certain disposal methods or long-term storage of IDW at the site. As with all CERCLA activities, site managers should evaluate community concerns regarding disposal of IDW in deciding what action to take. For example, if a community is concerned about the direct discharge of IDW water to surface water on site, site managers may want to consider sending the water to a POTW, if one is located nearby. In some instances, it may be appropriate to prepare fact sheets, include options in other community relations documents, or explain IDW management decisions at public meetings prior to actions.

SOP #3:
Dissolved Oxygen Measurement

Purpose

This guidance details the steps required to measure the dissolved oxygen concentration of an aqueous sample while in the field. Dissolved oxygen levels in natural water and wastewater depend on the physical, chemical, and biochemical activities in the water body. Conversely, the growth of many aquatic organisms as well as the rate of corrosivity and photosynthetic activity are dependent on the dissolved concentration. Thus, analysis for dissolved oxygen is a key test in water pollution and waste treatment process control, and environmental quality assessments of surface water bodies.

The guidance document is applicable to all aqueous samples such as groundwater, surface water, leachate, and other water samples. If the necessary length of cable is available, dissolved oxygen in monitoring well water can be analyzed in situ. Measurement of dissolved oxygen in groundwater from wells that are bailed is not recommended, as the water from the bail is aerated due to both the action of the bail entering the water column in the well, and during pouring of water from the bail into the sample measurement container.

Dissolved oxygen probes are normally electrochemical cells that have metals of different nobility immersed in an electrolyte. The electrolyte is retained by an oxygen-permeable membrane. The metal of highest nobility (the cathode) is positioned at the membrane. When a suitable potential exists between the two metals, reduction of oxygen to hydroxide ion occurs at the cathode surface. An electrical current is developed that is directly proportional to the rate of arrival of oxygen molecules at the cathode. A galvanic or an electrolytic cell can be used as the probe.

Because the current produced in the probe is directly proportional to the rate of arrival of oxygen at the cathode, it is important that a fresh supply of sample by in contact with the membrane; otherwise, the oxygen in the aqueous layer along the membrane is quickly depleted and false low readings are obtained. It is necessary to stir the sample or the probe constantly, but care must be taken to not aerate the sample. In most investigations, the dissolved oxygen meter will be part of a multi-probe meter that is mounted in a flow-through cell, so stirring of the probe will not be necessary.

Dissolved oxygen probes are relatively free of interferences. Interferences that can occur are reactions with gases such as chlorine or hydrogen sulfide. Also, some probes exhibit temperature sensitivity. Automatic temperature compensation is normally provided by the manufacturer. If gaseous interference is suspected, it should be noted in the field logbook and checked if possible.

Definitions

Galvanic Cell – An electrochemical cell in which chemical energy is spontaneously converted to electrical energy. The electrical energy produced is supplied to an external circuit.

Electrolytic Cell – An electrochemical cell in which electrical energy is supplied from an external source. The cell functions in much the same way as a galvanic cell, only in the opposite direction due to the external source.

Procedures

Follow the manufacturer's instructions regarding calibration, maintenance and use to obtain an accurate reading. The following general steps should be used to measure the dissolved oxygen concentration:

1. Install the multi-probe into the flow-through cell. Connect the tubing from the pump into the lower port on the flow-through cell. Connect a tube from the upper port, and place the other end of the tube into the purge water collection container. Start the pump.

2. Record the dissolved oxygen content and temperature of the sample. Record other parameters, as appropriate.

3. Recalibrate the probe when the membrane is replaced or as needed. Follow the manufacturer's instructions.

4. All data are to be recorded in the field logbook.

The field team leader is responsible for deciding when a dissolved oxygen measurement should be made. Details are given in the site-specific sampling plan. The field samplers are responsible for measuring the dissolved oxygen concentration and for recording and reporting the results.

SOP #6:
Field Decontamination

Introduction

This guideline is to provide general reference information on field decontamination.

Limitations

These limitations apply to all field decontamination activities excepting requirements of project-specific plans for field decontamination.

Definitions

The following terminology is applicable to field decontamination.

Decontamination. The process of neutralization, washing, rinsing, and removing contamination from exposed surfaces of equipment to minimize the potential for contaminant migration.

Cross-Contamination. The transfer of contaminants from their known or suspected location into a non-contaminated location.

Guidelines

Effective decontamination procedures are implemented to minimize the potential for cross-contamination and to minimize the potential for off-site contaminant migration (i.e., the transfer of contaminants to areas outside the exclusion zone, usually via improperly decontaminated equipment).

The generalized sequence of routine decontamination procedures for sampling equipment consists of a detergent wash (e.g., low-phosphate detergent), followed by a de-ionized water rinse to remove inorganic and organic contaminants. If muddy conditions prevail, it is recommended that the equipment be rinsed with tap water in a separate tub prior to the detergent wash. Heavy equipment, such as drill rigs and drilling equipment are normally steam-cleaned.

Non-routine decontamination procedures are employed when sampling equipment is visibly contaminated with oily wastes. When organic oily wastes are suspected on site, it becomes necessary to implement a decontamination procedure that will adequately remove the oily waste from contaminated sampling equipment. Consequently, the selection of decontamination solutions is based upon the miscibility of the decontamination solution with the oily contaminants.

Routine Decontamination Procedures for Sampling Equipment

For samples undergoing trace organic or inorganic constituents analyses, the following procedures are to be used for all reusable sampling equipment or components of equipment that come in contact with the sample:

1. Clean with tap water or de-ionized water and detergent using a brush, if necessary, to remove particulate matter and surface films. Equipment may be steam cleaned as an alternative to brushing. Sampling equipment that is steam cleaned should be placed on racks or saw horses at least two feet above the floor of the decontamination pad. PVC or plastic items should not be steam cleaned.

2. Rinse thoroughly with tap water or de-ionized water.

3. Air dry or dry with new, clean paper towels.

4. Place equipment in a new plastic bag or wrap in aluminum foil.

Decontamination Procedure of a Pump if Used to Evacuate/Sample a Well

New, clean polyethylene or Teflon tubing will be used for groundwater sampling, so decontamination of the tubing will not be necessary. The pump, support cable, and electrical wires must be decontaminated according to the following procedure prior to use:

1. Clean with tap water or de-ionized water and detergent using a brush, if necessary, to remove particulate matter and surface films (pump, wiring and reel).

2. Rinse thoroughly with tap water or de-ionized water (pump, wiring and reel).

3. Run the pump in a wash tub/container containing potable water for 5 minutes.

4. Rinse the pump with distilled/deionized water.

5. Air dry; place the equipment in a clean plastic bag while not in use or between sample locations.

Decontamination Procedure for Field Instruments

1. All field instruments will be cleaned as per the manufacturer's instructions.

2. All probes will be rinsed with DI water between sample locations.

Decontamination Procedure for the Exterior of Sample Containers After Sample Collection (if necessary)

1. Detergent and water wash.
2. Tap (or potable) water rinse.
3. Air dry or dry with a paper towel.

Non-Routine Decontamination Procedures for Sampling Equipment

1. Wash and scrub equipment with detergent. Alconox and water are generally used.*
2. Rinse with tap water.
3. Rinse with 10 percent nitric acid (HNO_3 redistilled).**
4. Rinse with tap water.
5. Rinse with methanol (pesticide-grade).
6. Rinse with hexane (pesticide-grade).
7. Rinse with analyte-free deionized water.
8. Air-dry.
9. Place in a new, clean plastic bag for storage and/or transport.

* If equipment is muddy, it should first be rinsed with water in a separate tub prior to the detergent and water scrub.

If the equipment is visibly oily, then it is rinsed with methanol, hexane, and methanol prior to the detergent and water scrub.

** One percent nitric acid must be used when decontaminating equipment composed of carbon steel.

Note: If metals analysis is not required, steps 3 and 4, the nitric acid rinse followed by tap water, may be omitted.

If organics analysis is not required, steps 5 and 6 (the methanol and hexane rinses) may be omitted.

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SOP #7:
Groundwater Level Measurement

Objective

The objective of these guidelines is to provide general reference information and technical guidance on the measurement of groundwater levels.

Limitations

These guidelines give overall technical guidance only and could be modified by specified requirements of project-specific plans for measuring groundwater levels in wells.

Definitions

Water table – The surface in an unconfined aquifer where groundwater pressure is equal to atmospheric pressure.

Piezometric (potentiometric) surface – An imaginary surface representing the total head of groundwater in an aquifer that is defined by the level to which water will rise in a well screened at and/or beneath the water table.

Guidelines

General

In measuring groundwater levels, there should be a clearly established reference point of known elevation, which is normally the top of the PVC well casing. The field notes recorded should clearly describe the reference used. To be useful, the reference point should be tied in with the USGS benchmark or a local datum. An arbitrary datum could be used for an isolated group of wells if necessary. (All groundwater level measurements shall be made and recorded to the nearest 0.01 foot.) After the groundwater observation standpipe has been installed or the cased borehole completed and left open, the initial depth to the water should be measured and recorded. The date and time of the reading should also be recorded. Information related to precipitation should be included in the data. The depth of the groundwater should be entered.

Appropriate remarks describing the history of the groundwater standpipe or open-cased borehole should be recorded along with the name of the individual who has read the groundwater levels in a monitoring well.

Readings should be taken regularly, as required by the field team leader. Groundwater standpipes or open-cased boreholes that are subject to tidal fluctuations should be read in conjunction with a tidal chart; the frequency of such readings should be established by the site geologist.

Equipment

Electronic Water Level Indicator – This instrument consists of a spool of graduated, small-diameter cable and a probe attached to the end. When the probe comes in contact with the water, the circuit is closed and a meter, light, and/or buzzer attached to the spool will signal the contact. Pen light batteries are normally used for a power source.

Groundwater Level Measuring Techniques

1. Ensure well is at equilibrium with atmospheric pressure (see note below).

2. Check operation of equipment above ground.

3. Record well number, top of casing elevation and surface elevation if available. Water levels should be taken from top of the protective casing or a reference point at the ground surface for borehole measurements. The distance between the top of the protective casing and inner casing should be recorded.

4. Record water level to the nearest 0.01 foot.

5. Measure depth to bottom of well to the nearest 0.01 foot. Compare results to well installation log. Record evidence of obstructions or siltation, odor, and other pertinent observations in the field logbook.

6. Record the time and day of the measurements.

Note: In flush-mounted wells with air tight plugs, or wells without vents, the hydraulic head may not be the same as in an open or vented well. Remove well cap and allow sufficient time for the well to equilibrate with atmospheric pressure. Several measurements may be needed to ensure equilibrium has been reached. This is especially important for deep wells.

When there is oil on the water, high specific conductance, water cascading into the well, or a turbulent water surface in the well, measuring with an electric sounder may be difficult. Before lowering the probe into the well, the circuitry can be checked by dipping the probe in water and observing the indicator. The probe should be lowered slowly into the well and once the buzzer sounds, slowly raised and lowered until it just ceases sounding. At this point the depth to water is read directly from the graduated cable at the reference point and recorded to the nearest 0.01 feet.

SOP #8:
Groundwater Monitoring Well Inspections

Introduction

Sites with groundwater monitoring wells require periodic inspections of the wells to determine their integrity and functionality. If available, boring logs and well construction diagrams would be useful to review prior to conducting an inspection. In addition to periodic inspections on sites with established programs, inspections are important to gain information on the usefulness of wells where we are new to the site and/or the wells have not been regularly sampled. A simple checklist on a groundwater monitoring well inspection form can be used to record observations.

Equipment

- Groundwater Monitoring Well Inspection Forms
- Site Map
- Camera and Film
- Well Keys
- New Locks
- Bolt Cutters
- Measuring Tape/Wheel
- Water Level Probe
- Photoionization Detector (PID)
- Bailer with Rope
- Turkey Baster (or other suction tool)
- Boring Logs/Construction Diagrams

Procedures

1. Field Forms

A groundwater monitoring well inspection form will be used for each monitoring well to record relevant observations. The form should include the information on the outward appearance, inner appearance, and downhole features as described below (see sample form attached). Any additional observations should be recorded at the bottom of the form.

2. Outward Appearance

a. Locate well and determine well identification.
b. Determine if there are any problems accessing the well.
c. Describe approximate location relative to fixed landmarks or provide a sketch with measures to fixed landmarks.
d. Measure and record flushmount diameter or stickup height.
e. Record the integrity of, material, and width or diameter of the protective casing.

f. Identify if there is a weep hole in the protective casing.
g. Document the integrity of the surface seal/apron if one exists. If so, determine the material of which it was constructed (cement, bentonite, etc.).
h. Determine if surface drainage will pond up near the well and potentially flow into the well or if drainage is away from the wellhead. Identify if there is any evidence of erosion of soils in the immediate area around the well casing. Determine if frost heave has damaged the concrete pad.
i. Record where any bollards are/should be present on a sketch and describe their condition.
j. Determine the condition of any paint or markings on the well casing, cap, or bollards.
k. Record if a well identification designation is present on the well and legible.
l. Document if a lock is present and functional (aboveground completion), or if tie-down bolts are present and functional (flush-mounted completion).
m. Take a photograph and describe on inspection form.

3. Inner Appearance

a. Document if a lock is present and functional (flush-mounted completion).
b. Unlock well, if applicable, or remove .
c. Describe the integrity of, material, and width or diameter of the well casing.
d. Verify if an inner cap exists and, if so, document the type of cap (i.e., threaded, slip, expansion plug).
e. Record if a reference/measuring point exists and, if so, the type of point (i.e., groove, indelible ink mark).
f. Determine if there is a dedicated bailer or tubing in the well.
g. Identify if there is any evidence that the well is double cased.
h. For flushmount wells (or stick-ups without weep holes or proper seals), indicate if water is present inside the casing and if surface water has the potential to enter the well. Purge the water from the casing with a suction tool, bailer, or sponge, as applicable. Inspect the rubber seal between the casing and the cap and confirm that all bolts are present and functioning.

4. Downhole

a. Stand upwind, open the wellhead and collect a headspace PID reading.
b. Describe any odors.
c. Describe if the well casing is offset or bent.
d. Measure and record the depth to water, depth to LNAPL (if applicable), and total well depth with a water level probe (Do not remove any dedicated bailer or tubing prior to measuring).
e. Measure total depth of well
f. Determine if there is any sediment at the bottom of the well and describe if it is hard or soft.

5. Post Inspection

a. Replace inner cap and well cover
b. Lock the well, if applicable.
c. If it is a flushmount well, remove debris from around the well cover and replace bolts if they have been stripped or are missing. Make sure rubber seal between the casing and the cap is present and free of debris or tears.
d. Document warranted maintenance items on Well Inspection Report and indicate completion date for actions.

SOP #9:
Groundwater Monitoring Well Development

Introduction

Drilling a borehole for monitoring well installation or sampling disrupts the natural alignment of soil particles in the formation adjacent to the borehole. With some drilling methods, bentonite or other fine-grained materials are added to drilling fluids to generate drilling mud, which is used to maintain an open borehole. The physical disturbance of the subsurface soils, and in some cases the use of drilling mud, affects the hydraulic conductivity of the saturated formation adjacent to the well and can create a "skin" of fine-grained material along the annulus of the borehole. The objectives of well development are to restore the natural alignment of soil particles to the extent possible, remove finer-grained particles and drilling fluids in and adjacent to the well, and ensure that water in the well is representative of formation groundwater. The appropriate development method to use will vary according to the hydraulic characteristics of the aquifer, the drilling method used, and the type of well completion. Of the various methods available for use in developing wells, mechanical surging, pumping, backwashing, and bailing are best suited for developing monitoring wells.

Techniques and Associated Equipment

The necessary equipment, monitoring instruments and field procedures are presented herein for four monitoring well development techniques. Since other procedures may be applicable depending on site conditions, references are provided for more complex development needs, including predevelopment techniques. Development using any of these methods should not be initiated less than 24 to 48 hours after final grouting of the monitoring well (USACE, 1998).

1. Mechanical Surging

Operation of a piston-like device (surge block) in combination with periodic purging of water from the well is a very effective development method, even in stratified formations with variable hydraulic conductivity. The surge block should be constructed with rubber disks secured to stainless steel or PVC pipe with a pipe fitting on top to attach it to drill rods or HDPE tubing. The rubber discs on the surge block should be slightly smaller than the inside diameter of the well. The surge block is carefully lowered into the well and an up-and-down plunging action is used to alternately force water to flow into and out of the well, similar to a piston in a cylinder. The use of a surge block can agitate and mobilize particulates around the well screen. Periods of surging should be alternated with periods of water extraction from the well so that sediment brought into the well is removed. Surging should initially be gentle to assure that water can come into the well and that the surge block is not so tight as to damage the well pipe or screen. For short well screens (1.6 m (5 ft) or less) in relatively homogeneous formations, the surge block does not have to be operated within the screen interval. However, if the screened interval includes materials of high and low hydraulic conductivities, the block may have to be operated gently within the screen.

Equipment needed for mechanical surging would include:

- Surge block
- HDPE pipe if drilling rig not used
- Water-level probe
- Pump or bailer for purging
- Graduated bucket or flow meter to measure volume of water removed
- Multi-parameter field instrument (at a minimum able to measure pH, specific conductance, turbidity, and temperature)

2. Backwashing

Backwashing is the reversal of flow through a well screen by first drawing water up through the well with a pump and then releasing the water back into the well. When supplemented with periodic purging, backwashing facilitates the removal of fine-grained materials from the formation surrounding the borehole. The well is pumped until water reaches the surface. At this point the pump is shut off, and water in the hose is drained by gravity creating a reversed flow through the well screen. At times this method can be effective; however in low hydraulic conductivity formations the flow may not be sufficient to achieve the desired results.

Equipment needed for backwashing would include:

- Water-level probe
- Pump for purging
- Tubing with no backflow preventer or check valve
- Graduated bucket or flow meter to measure volume of water removed
- Multi-parameter field instrument (at a minimum able to measure pH, specific conductance, turbidity, and temperature)

3. Bailing

The use of bailers is an effective way of manually developing small diameter wells that have a high static water table or are relatively shallow in depth (generally less than 20 feet). Since the diameter of the bailer is commonly close to the same diameter as the well screen, the bailer agitates the water in the well in much the same manner as a surge block. The well should be surged using the bailer for 10 to 20 minutes prior to beginning bailing. To have its most effective surging action, the bailer should be operated throughout the screened interval. Bottom loading bailers can extract sediment that has settled to the bottom of the well by rapid short upward/down motions of the bailer at the bottom of the well.

Equipment needed for bailing would include:

- Water-level probe
- Weighted, bottom-filling bailer (sized appropriately depending on well diameter)
- Graduated bucket or flow meter to measure volume of water removed

- Multi-parameter field instrument (at a minimum able to measure pH, specific conductance, turbidity, and temperature)

4. Overpumping

Overpumping is a commonly used development method and consists of pumping a well at a higher rate than water will be extracted during purging or sampling events. This overpumping, however, is usually only successful in relatively non-stratified, relatively homogeneous and permeable formations. By pumping the well at a higher rate than expected during sampling, the particulates may be mobilized and removed. Overpumping should be supplemented with the use of a bottom discharge/filling bailer, (for sediment removal). During development, water should be removed throughout the entire water column in the well by periodically lowering and raising the pump intake.

A disadvantage of only pumping the well is that the smaller soil grains of the filter pack may be bridged in the screen or in the filter pack, as the direction of flow is only toward the screen. To overcome this, overpumping is often used in conjunction with backwashing or surging. This technique is probably the least effective because the well development is occurring in the most permeable zones, often near the top of the well screen (Driscoll 1986). Additionally, overpumping may actually compact finer-grained soils.

Equipment needed for overpumping would include:

- Water-level probe
- Pump for purging
- Graduated bucket or flow meter to measure volume of water removed
- Multi-parameter field instrument (at a minimum able to measure pH, specific conductance, turbidity, and temperature)

Procedures

Well development can be conducted by a drilling contractor or manually by field personnel. In either case, the techniques discussed above should be used and the procedures below should be followed and documented.

1. Preparation

In preparation of monitoring well development:

- Coordinate site access and obtain keys to well locks.
- Obtain information on each well to be developed (i.e., drilling method, well diameter, well depth, screened interval, anticipated contaminants).
- Obtain a water level meter, a weighted tape to measure well depth, air monitoring instruments and materials for decontamination, if necessary, and water quality instrumentation capable of measuring, at a minimum, pH, specific conductivity, temperature, and turbidity.

- Assemble graduated containers for temporary storage and measurement of water removed during well development. Containers must be structurally sound, compatible with anticipated contaminants, and easy to manage in the field. The use of truck-mounted or roll-off tanks may be necessary in some cases; alternately, a portable water treatment unit (i.e., activated carbon) may be used to treat the purge water.

2. Operation

Development should be performed as soon as it is practical after the well is installed, but no sooner than 48 hours after well completion to allow grout to set. No water shall be added to the well to assist development without prior approval of the regulatory agency. In some cases, small amounts of potable water could be added to help develop a poor yielding well. If practicable, at least five times the amount of water added should be recovered from the well to ensure that all added water is removed from the formation.

For typical well development, a minimum of three borehole volumes of water should be removed and water quality parameters should be measured in the field until it is evident that water purged from the well is representative of formation water. A borehole volume includes the volume of the water column in the well and the volume of water in the saturated portion of the filter pack. Assume 30 percent porosity of the filter pack unless more site-specific information is available. If drilling fluids were used or lost to the formation during well installation, a minimum of five times the estimated quantity of un-recovered water should be removed in addition to the minimum three borehole volumes.

Use the attached Monitoring Well Development/Purging Log and follow these procedures to develop a monitoring well:

- Assemble necessary equipment on a plastic sheet surrounding the well.
- Record pertinent information in the site or personal logbook (client, project, personnel, date, time, location ID, weather conditions, etc.).
- Open monitoring well and measure air quality at the top of casing and in the breathing zone as appropriate.
- Measure and record depth to water and the total depth of the monitor well. Calculate the water column and borehole volume of the well. Note hard or soft bottom to indicate presence or absence of fines in the well.
- Begin development and measure the initial pH, temperature, turbidity, and specific conductivity (at a minimum) of the water and record in the site logbook. Note the initial color, clarity, and odor of the water.
- Continue to develop the well and periodically measure the water quality parameters indicated in step 5 (above). Depending on project objectives, development should proceed until these water quality parameters stabilize, or until the water has a turbidity of less than a predetermined threshold, preferably between 5 and 50 nephelometric turbidity units (NTUs). This may not be obtainable in some fine-grained formations.
- Measure and record the volume of water removed during development, either with a flow meter or a graduated container. Estimate and record the well recovery rate if water is purged during development.

- Containerize or treat water produced by development of contaminated or suspected contaminated wells. Each container must be clearly labeled with the well ID, date collected, and sampling personnel. Determination of the appropriate disposal method will be based on the analytical results from each well and regulatory requirements.
- Note the final water quality parameters in the logbook along with the following data:

    1. Well designation (location ID)
    2. Date(s) of well installation
    3. Date(s) and time of well development
    4. Static water level before and after development
    5. Quantity of water removed, and initial and completion time
    6. Type and capacity of pump or bailer used
    7. Description of well development techniques

3. Post-Operation

Follow these procedures to demobilize upon completing well development:

- Decontaminate all equipment
- Secure and label holding tanks or containers of development water
- Review analytical results and determine the appropriate water disposal method

References

Driscoll, Flecther G., 1986. *Groundwater and Wells*. Johnson Screens, pp 497-507.

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SOP #10:
Groundwater Sampling – Volumetric Method

Purpose/Application

This guideline is to provide general reference information on groundwater sampling.

Recommended Equipment

Centrifugal Pump. A shallow-well suction pump with a centrifugal impeller to create suction which draws groundwater from a monitoring well through an inlet hose. The use of centrifugal pumps is limited by the depth of the water column within the well. The total lift, including the well stick-up above ground surface, cannot exceed 28 feet. In most cases, centrifugal pumps will not operate efficiently if the lift is greater than 20-22 feet; as the water level of the well drops, so does pumping efficiency.

Submersible Pump. A deep-well impeller pump, submerged within the water column of a well, which forces water up through the outlet hose.

Bailer. A tall, narrow, stainless steel or Teflon container equipped with a check valve on the bottom. The check valve allows water to enter from the bottom as the bailer is lowered, then prevents its release when the bailer is raised.

Electronic Water Level Indicator. An electronic water level indicator is used to measure the depth to water in a well. The electronic water level indicator consists of a ruled electrical cable to determine depth and a contact electrode. When the electrode contacts groundwater, an electronic circuit is completed that emits a sound and lights a light bulb. Upon contact, the depth to groundwater is read directly from the ruled electrical cable (at the established measuring point on the top of casing).

Procedures

Collection of groundwater samples from monitoring wells on or near a hazardous waste site may be required to document a release of hazardous substance or petroleum has or may have occurred on, underlying or emanating from the property. To properly document groundwater contamination, a minimum of three well sampling points are typically required (i.e., one upgradient well to identify ambient groundwater quality and two downgradient wells to document contamination of the aquifer). The selection of monitoring wells for groundwater sampling is determined by the hydraulic gradient within the local aquifer. The locations of soil borings and monitoring wells should be selected in compliance with Rule 3745-300-07 “Phase II Property Assessments” of the Ohio Administrative Code.

After the initial static water level within the monitoring well has been measured, the monitoring well must be purged to remove stagnant water from the well casing so that representative “formation” water will flow into well for sampling. Typically, a well should be purged until

indicator parameters stabilize over at least three successive readings collected at approximately 5-minute intervals (a reasonable interval is contingent on the purge rate of the method and should be determined by field personnel) when pumping or every 0.5 well volumes (after the first full well volume) if bailing the wells. The most common indicator parameters are temperature, pH, and conductivity (or specific conductance). Of these three, temperature is considered the least important, being most susceptible to "noise" from the current weather conditions. Other stabilization parameters that may be included on a site-by-site basis include turbidity and dissolved oxygen. Typically, three to five well volumes will need to be purged to stabilize; if five well volumes are reached and parameters do not stabilize, field personnel should check equipment and re-calibrate, if necessary. Subject to professional judgment, five well volumes purged is generally considered sufficient to ensure formation water entering the well screen, even if the field parameters are not stabilizing within recommended criteria.

Recommended stabilization criteria for each parameter are as follows:

Parameter	Acceptable Range	Comment
Temperature	±0.5 ^{o}C	If possible; least important and reliable parameter for stabilization
pH	±0.1 SU	May not stabilize with bailers or other purging methods that may disturb (aerate) the groundwater; not particularly sensitive to stagnant vs. formation water
Specific Conductance (Conductivity)	±3%	
Turbidity	±10%	Or <10 NTU, if possible; not particularly sensitive to stagnant vs. formation water
Dissolved Oxygen	±0.3 mg/l	May not stabilize with bailers or other purging methods that may disturb (aerate) the groundwater

Once the monitoring well has been properly evacuated, groundwater samples should be collected as soon as sufficient volume has recharged into the well to permit sampling. Whenever full recovery exceeds 3 hours, groundwater samples should be collected in order of their volatility, with the VOA fraction collected within 3 hours of evacuation if possible. Parameters that are not subject to loss through volatilization should be collected last.

Generally, the following considerations should be taken into account during groundwater sampling activities.

A. All equipment entering the well should be clean.

B. Do not allow bailers or pumps to drop freely into the well.

C. New outer gloves must be donned before sampling or handling clean equipment.

D. Verify that the laboratory has provided appropriate, pre-preserved sample bottles/containers.

E. The list of chemicals of concern and the required lab analyses will be established by the Certified Professional, and will be included in the Sampling and Analysis Plan (SAP). The bottle order from the laboratory will reflect the necessary laboratory analyses, and the order of sample collection should be as follows, unless an alternate order is specified in the SAP.

1. Volatile Organic Compounds (VOCs)
2. Semi-Volatile Organic Compounds (SVOCs)
3. VAP Metals/Inorganics
4. Dissolved Metals/Inorganics
5. Sulfate, Chloride, TDS, Alkalinity, Turbidity (if not measured in the field)
6. Nitrate/Nitrite and Ammonia
7. Cyanide
8. Turbidity
9. Radionuclides

Notes for Filling VOC Vials:

Vials for the VOC analyses must be filled carefully to avoid trapping air bubbles. This is best accomplished by tilting the vial slightly so that sample water flows in slowly down the inner edge of the vial. The vial should be filled until there is a positive meniscus above the rim and the cap then carefully screwed on. Invert the vial to verify that there are no air bubbles present. If air bubbles are trapped, attempt to eliminate by gently tapping the upright vial to force the bubbles to the top, remove the cap, and carefully top of the sample. If bubbles persist, then either re-collect the sample in a new (pre-preserved) vial or, in extreme cases where the preservative may be reacting and contributing to bubble formation, collect an unpreserved sample and note this on the label and chain-of-custody (unpreserved VOC samples have a 7-day holding time).

Notes for Field Filtering:

If the SAP requires or allows for field filtering groundwater samples and filtering is deemed necessary, field personnel should use the following procedure:

1. If possible, use a positive-pressure, in-line filtering method with the sampling pump (or bailer if it is equipped with a bottom-loading valve and can be pressurized with a hand pump).
2. If an “open” filtering system must be used, care should be taken to minimize sample disturbance as it is transferred to an intermediate container before being passed through the filter. Open filtering should also be conducted as

soon as possible after retrieval of the sample and before preservation to minimize potential precipitation or degassing.

3. Use a disposable, inert filter with a minimum pore size of 0.45 microns (e.g., QED Quickfilter). Alternate pore sizes can be determined on a site-specific basis, but the filter pore size should not be finer than the largest mobile fraction of particulates anticipated in the formation.
4. Pre-rinse the filter to remove potential residue from the manufacturer. Flush with sample water to create a uniform wetting front.
5. Decontaminate or dispose filtration equipment (filter, tubing, etc.), as appropriate.

Procedure to Evacuate Monitoring Wells

Methods used to evacuate monitoring wells are dependent upon the depth of the well. Wells under 28 ft. in depth from the top of the stick-up to the bottom of the well may be evacuated using surface-positioned pumps or may be bailed. Wells with a depth greater than 28 ft. from the top of the stick-up to the bottom of the well may be evacuated using submersible pumps or may be bailed.

Procedure to Determine the Volume of Standing Water in a Monitoring Well

Prior to collection of groundwater samples from a monitoring well, three to five volumes of standing water must be removed from the well to ensure that the samples collected are representative of the groundwater in the aquifer of concern. The procedure for determining the volume of standing water in a monitoring well is as follows.

1. Clean all down-hole equipment according to all established decontamination procedures.

2. Measure the depth to groundwater from the measuring point on the top of the well casing.

3. Note the diameter of the well; determine the radius.

4. Determine the depth of the water column in the well by subtracting the depth to the bottom of the well from the depth to groundwater.

5. Determine the volume of standing water in the well.

6. Multiply the volume of standing water in the well by 3 to 5 to calculate the anticipated purge volume.

After the proper evacuation of a monitoring well, groundwater samples may be collected.

Procedure for Groundwater Sampling Using a Bailer

Procedures for the collection of groundwater samples using a bailer are as follows. Only new disposable or dedicated bailers will be used to evacuate and sample groundwater from monitoring wells.

1. Carefully lower the bailer into the well to mid-screen depth to collect the sample. Do not allow the bailer to freely drop into the well.

2. Carefully raise the bailer from the well. Do not allow the bailer rope to come in contact with the ground surface.

In the event that a bailer is lost down a monitoring well, the bailer can be easily retrieved using a fishhook or lure (e.g., a 1½ oz. Diamond Jig (obtained from a Sporting Goods store) attached to either a length of the bailer guy line or to a length of monofilament fishing line.

References

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SOP #11:
Low-Flow Groundwater Sampling

Purpose/Application

This low-flow groundwater purging and sampling procedure presents a standard method for collecting groundwater samples that are representative of the formation from which they are being withdrawn. By using low flow rates for purging and sampling to minimize drawdown within the well, three primary benefits gained. First, using a low flow rate during sampling promotes laminar flow, which minimizes the disturbance of sediment at the bottom of a well or fine particles in the well's filter pack. Groundwater samples are therefore less turbid, which reduces sampling time and generally eliminates the need to filter. Second, the amount of groundwater purged from the sampling well is significantly reduced, minimizing investigation derived waste. Third, low flow purging and sampling reduces aeration and therefore helps to preserves the natural chemical characteristics of the groundwater sample. Low flow sampling may be used to collect groundwater samples for analysis of contaminants of concern, as well as geo-chemical and biological parameters.

This guideline is for information purposes and should not take precedence over the requirements of project specific plans. This is especially true for federal project sites, which are governed by regionally directed United States Environmental Protection Agency (USEPA) low-flow groundwater sampling protocols.

Equipment

Low flow groundwater sampling requires traditional groundwater sampling equipment with the addition of the following:

- Multi-parameter water quality monitoring system
- An adjustable rate groundwater pump (e.g., centrifugal, submersible, or bladder pumps) capable of achieving low flow pumping rates (i.e., 100 to 500 ml/min).
- New disposable polyethylene tubing (or equivalent) for use at each well.
- Flow measurement device (e.g., a graduated container and stop watch).
- A water level probe or oil/water interface probe.

Sampling Procedures

The procedures for collecting groundwater samples using low flow are as follows:

1. **Pump Installation:** Install the pump by slowly lowering the pump assembly and tubing into the well. The pump should be set to the appropriate depth with the intake being a minimum of two-feet above the bottom of the well to prevent disturbing and re-suspending any sediment at the bottom of the well.

2. **Water Level Measurement:** Measure the depth to groundwater from the top of the well casing using a water level probe. Leave the probe in the well for subsequent water level measurements.

3. **Purging:** Begin purging the well at a rate of 200 to 500 milliliters per minute (ml/min) and measure the water level. If excessive drawdown is observed in the well, reduce the flow rate until the water level stabilizes. When the water level has stabilized, subsequent measurements should be made on five minute intervals. The flow rate, as well as flow rate adjustments should be recorded on a field purge log. If the water level does not stabilize, continue purging until the well is purged dry. Collect field parameters as purging progresses. Sample the well when sufficient water is available.

4. **Field Parameter Monitoring:** Field parameters (e.g., pH, conductivity, reduction/oxidation potential, DO, and turbidity) should be recorded every five minutes with water level measurements. The well is considered stable and ready to be sampled once the field parameters are stable over three consecutive readings (USEPA Region 2, 1998). Recommended stabilization criteria for each parameter are as follows:

Parameter	Acceptable Range	Comment
Temperature	±0.5 ^{o}C	If possible; least important and reliable parameter for stabilization
pH	±0.1 SU	May not stabilize with purging methods that disturb (aerate) the groundwater; not particularly sensitive to stagnant vs. formation water
Specific Conductance (Conductivity)	±3%	
Turbidity	±10%	Or <10 NTU, if possible; not particularly sensitive to stagnant vs. formation water
Dissolved Oxygen	±0.3 mg/l	May not stabilize with purging methods that disturb (aerate) the groundwater

The pump should **not** be removed or shut off between purging and sampling.

5. **Sample Collection:** Disconnect the inflow line from the pump to the flow through cell and collect the groundwater sample (do not sample water that has gone through the flow-through cell). If necessary, reduce the flow rate to 100 to 250 ml/min to reduce turbulence while filling sample containers during sample collection. Where wells are purged at a flow rate less than 100 ml/min, use the same flow rate during sample collection. All sample containers should be filled directly from the tubing. Allow water to flow from the tubing down the inside of the containers to minimize turbulence during sample collection. Groundwater samples should be collected in order of importance, according to the project requirements. If there is not an issue with recharge of the well,

the samples should be collected from the most volatile parameter group to the least volatile parameter group (e.g. VOCs first, SVOCs second, and metals last).

6. **Pump Removal:** Once sampling is complete, slowly remove the pump assembly and tubing from the well.

7. **Secure Well:** Secure the top of the well casing with a locking cap or expansion plug and close the well. In the case of a stick-up protective well cover, lock the outer casing.

Notes for Filling VOC Vials:

Vials for the VOC analyses must be filled carefully to avoid trapping air bubbles. This is best accomplished by tilting the vial slightly so that sample water flows in slowly down the inner edge of the vial. The vial should be filled until there is a positive meniscus above the rim and the cap then carefully screwed on. Invert the vial to verify that there are no air bubbles present. If air bubbles are trapped, attempt to eliminate by gently tapping the upright vial to force the bubbles to the top, remove the cap, and carefully top of the sample. If bubbles persist, then either re-collect the sample in a new (pre-preserved) vial or, in extreme cases where the preservative may be reacting and contributing to bubble formation, collect an unpreserved sample and note this on the label and chain-of-custody (unpreserved VOC samples have a 7-day holding time).

Notes for Field Filtration:

If the SAP requires or allows for field filtering groundwater samples and filtering is deemed necessary, field personnel should use the following procedure:

1. Use a positive-pressure, in-line filtering method with the sampling pump.
2. Use a disposable, inert filter with a minimum pore size of 0.45 microns (e.g., QED Quickfilter). Alternate pore sizes can be determined on a site-specific basis, but the filter pore size should not be finer than the largest mobile fraction of particulates anticipated in the formation.
3. Pre-rinse the filter to remove potential residue from the manufacturer. Flush with sample water to create a uniform wetting front.
4. Decontaminate or dispose filtration equipment (filter, tubing, etc.), as appropriate.

Field Sampling Form

Field sampling forms developed for the project or field log books may be used to record field data.

Potential Problems/Troubleshooting

Insufficient yield, cascading, field parameters failing to stabilize, and aerating the groundwater sample are potential problems when trying to use low flow protocols to collect representative groundwater samples.

Field Parameters Fail to Stabilize

If any parameters fail to stabilize within four hours of purging, then the following alternatives should be considered:

1. Continue purging until stabilization.
2. Stop purging, do not collect a sample, and document the activity.
3. Stop purging, collect a sample, and document the activity.
4. Stop purging, secure the well, and resume purging the following day.

Non-stabilizing turbidity measurements may be avoided by periodically removing sediments that may be trapped in the flow through cell during purging. Trapped sediments may cause artificial fluctuations in turbidity measurements. Additionally, the sampler should visually compare the turbidity of the groundwater in the Cell with the groundwater entering the Cell. If the groundwater entering the Cell is clearer, disconnect the inflow line, drain the turbid groundwater from the Cell, and reconnect the inflow line. Turbidity readings should more accurately reflect true groundwater conditions.

Fluctuations in DO measurements may be caused by air bubbles that form in the flow through cell or sample tubing. Ensure that the inflow tubing is sealed tightly to the flow through cell to prevent the intrusion of air. It may be necessary to drain the flow through cell to remove all air bubbles that may interfere with accurate DO readings.

References

Ohio EPA, 2012. Technical Guidance Manual for Ground Water Investigations. Chapter 10: Ground Water Sampling. Division of Drinking and Ground Waters. Ohio Environmental Protection Agency, Columbus, OH. May 2012.

United States Environmental Protection Agency (USEPA) Region II, 1998, Ground Water Sampling Procedure, Low Stress (low flow) Purging and Sampling, GW Sampling SOP, March 16th.

SOP #12:
pH and Conductivity Measurement

Introduction

This guideline is to provide reference information on the measurements of conductivity and pH in aqueous solutions.

Limitations

These limitations apply to all measurements of pH and conductivity excepting requirements of project-specific plans for measurements of pH and conductivity.

Definitions

pH. The negative logarithm (base 10) of the hydrogen ion activity. The hydrogen ion activity is related to the hydrogen ion concentration, and, in relatively weak solution, the two are nearly equal. Thus, for all practical purposes, pH is measure of the hydrogen ion concentration.

pH Meter. The pH meter consists of a potentiometer, a reference electrode, a glass electrode, and a temperature compensating device. A balanced circuit is completed through the potentiometer when the electrodes are immersed in the sample. The reference electrode consists of a half cell that provides a standard electrode potential. The liquid junction of the reference electrode forms a salt bridge with the sample and a liquid junction potential is generated that in turn affects the potential produced by hydrogen ions.

Resistance. A measure of the degree to which a material (groundwater) opposes the flow of current. For metals and solutions the resistance is defined by Ohm's law, $E = IR$, where E is the potential difference, I is current, and R is the resistance.

Conductance. The reciprocal of the resistance, $1/R$.

Specific Conductance. The conductance of a 1-cm cube of electrolyte. Conductivity and specific conductance are used synonymously; this SOP will use the term "conductivity".

Conductivity Meter. The conductivity meter consists of a conductivity cell, a temperature compensating device, and a Wheatstone bridge to measure the electrical resistance of a sample by measuring the ratio of alternating current through the conductivity cell to the voltage across the cell.

Guidelines

Measurement of pH and conductivity is required to document original equilibrium conditions of the aqueous sample at the time of sample collection. For example, the physio-chemical equilibria of the water in a groundwater system may change after the groundwater is collected and put into a sample bottle. Though the water in the sample bottle may be representative of physio-chemical

equilibria in the groundwater system at the time of collection, days or weeks later when the sample is analyzed, the measured parameters may change and have no relation to original conditions. The influence of such physio-chemical changes on analytical results may have to be taken into account when evaluating the potential of contaminants in the groundwater system sampled.

Procedure for Measurement of pH and Conductivity

1. Prepare and calibrate the meter each day in accordance with the manufacturer's instructions. The pH portion of the meter will be calibrated with pH 7, 4 and 10 calibration buffer solutions. The conductivity portion of the meter will be calibrated with a 1413 μS solution.

2. Additional pH calibration checks may be necessary during the course of sampling. Calibration checks may be conducted using two solutions that bracket the observed pH of the groundwater.

3. Immerse the electrode in the groundwater sample.

4. Read and record the temperature, pH and conductivity of the sample.

5. Rinse the electrodes with distilled/deionized water.

6. Keep the electrode immersed in water when not in use.

References

Standard Methods for the Examination of Water and Wastewater. 16th Edition Method 205: Conductivity, pp 76-79. Method 423: pH Value, pp 427-434. American Public Health Association, Washington, D.C. 1985.

Chemistry for Environmental Engineering. 3rd Edition. Chapter 15 pH, pp 351-357 Clair N. Sawyer and Perry L. McCarty, McGraw-Hill Publishing Company 1978.

SOP #14:
Sample Packaging and Shipping

Purpose/Application

This Standard Operating Procedure (SOP) describes the chain-of-custody, handling, packing, and shipping procedures for the management of samples to decrease the potential for cross-contamination, tampering, mis-identification, and breakage, and to insure that samples are maintained in a controlled environment from the time of collection until receipt by the analytical laboratory.

Personnel Qualifications

T&M field sampling personnel will have current health and safety training, including 40-hour HAZWOPER training, Department of Transportation (DOT) training, site supervisor training, and site-specific training, as needed. In addition, T&M field sampling personnel will be versed in the relevant SOPs and possess the skills and experience necessary to successfully complete the desired field work.

Equipment List

The following list provides materials that may be required for each project. Project documents and sample collection requirements should be reviewed prior to initiating field operations:

- Indelible ink pens (black or blue)
- Polyethylene bags (resealable)
- Clear packing tape, strapping tape, duct tape
- Chain of custody
- DOT shipping forms, as applicable
- Custody seals or tape
- Appropriate sample containers and labels
- Insulated coolers of adequate size for samples and sufficient ice to maintain 4°C during collection and transfer of samples
- wet ice
- Cushioning and absorbent material (e.g., bubble wrap or bags)
- Temperature blank, if applicable
- Sample return shipping papers and addresses
- Field notebook

Cautions

Review project requirements and select appropriate supplies prior to field mobilization. Ensure that appropriate sample containers with applicable preservatives, coolers, and packing material

have been supplied by the laboratory. Understand the offsite transfer requirements for the facility at which samples are collected.

If overnight courier service is required schedule pick-up or know where the drop-off service center is located and the hours of operation. Prior to using air transportation, confirm air shipment is acceptable under DOT and International Air Transport Association (IATA) regulation. Schedule pick-up time for laboratory courier or know location of laboratory/service center and hours of operation.

Understand DOT and IATA shipping requirements and evaluate dangerous goods shipping regulations relative to the samples being collected. Review the T&M SOPs for shipping, packaging and labeling of dangerous goods. Potential samples requiring compliance with this DOT regulation include:

- Methanol preservation for Volatile Organic Compounds in soil samples
- Non-aqueous phase liquids (NAPL)

Health and Safety Considerations

Follow health and safety procedures outlined in the project/site Health and Safety Plan (HASP). Use caution and appropriate cut resistant gloves when tightening lids to 40 mL vials. These vials can break while tightening and can lacerate hand. Amber vials (thinner glass) are more prone to breakage.

Some sample containers contain preservatives.

- The preservatives must be retained in the sample container and should in no instance be rinsed out.
- Preservatives may be corrosive and standard care should be exercised to reduce potential contact to personnel skin or clothing. Follow project safety procedures if spillage is observed.
- If sample container caps are broken discard the bottle. Do not use for sample collection.

Chain-of-Custody Procedure

1. Prior to collecting samples, complete the chain-of-custody record header information by filling in the project number, project name, and the name(s) of the sampling technician(s) and other relevant project information.

2. Chain-of-custody information MUST be printed legibly using indelible ink (black or blue).

3. After sample collection, enter the individual sample information on the chain-of- custody:

a. Sample Identification indicates the well number or soil location that the sample was collected from.

b. List the date of sample collection. The date format to be followed should be mm/dd/yy (e.g., 03/07/09) or mm/dd/yyyy (e.g. 03/07/2009).

c. List the time that the sample was collected. The time value should be presented using military format. For example, 3:15 P.M. should be entered as 15:15.

d. The composite field should be checked if the sample is a composite over a period of time or from several different locations and mixed prior to placing in sample containers.

e. The "Grab" field should be marked with an "X" if the sample was collected as an individual grab sample. (e.g. monitoring well sample or soil interval).

f. Any sample preservation should be noted.

g. The analytical parameters that the samples are being analyzed for should be written legibly on the diagonal lines. As much detail as possible should be presented to allow the analytical laboratory to properly analyze the samples. For example, polychlorinated biphenyl (PCB) analyses may be represented by entering "PCBs" or "Method 8082." Multiple methods and/or analytical parameters may be combined for each column (e.g., PCBs/VOCs/SVOCs or 8082/8260/8270). These columns should also be used to present project-specific parameter lists (e.g., Appendix IX+3 target analyte list. Each sample that requires a particular parameter analysis will be identified by placing the number of containers in the appropriate analytical parameter column. For metals in particular, indicate which metals are required.

h. Number of containers for each method requested. This information may be included under the parameter or as a total for the sample based on the chain of custody form used.

i. Note which samples should be used for site specific matrix spikes.

j. Indicate any special project requirements.

k. Indicate turnaround time required.

l. Provide contact name and phone number in the event that problems are encountered when samples are received at the laboratory.

m. If available attach the Laboratory Task Order or Work Authorization forms n. The remarks field should be used to communicate special analytical requirements to the laboratory. These requirements may be on a per sample basis such as "extract and hold sample until notified," or may be used to inform the laboratory of special

reporting requirements for the entire sample delivery group (SDG). Reporting requirements that should be specified in the remarks column include:

i. turnaround time
ii. contact and address where data reports should be sent
iii. name of laboratory project manager
iv. type of sample preservation used

n. The "Relinquished By" field should contain the signature of the sampling technician who relinquished custody of the samples to the shipping courier or the analytical laboratory.

o. The "Date" field following the signature block indicates the date the samples were relinquished. The date format should be mm/dd/yyyy (e.g., 03/07/2005).

p. The "Time" field following the signature block indicates the time that the samples were relinquished. The time value should be presented using military format. For example, 3:15 P.M. should be entered as 15:15.

q. The "Received By" section is signed by sample courier or laboratory representative who received the samples from the sampling technician or it is signed upon laboratory receipt from the overnight courier service.

3. Complete as many chain-of-custody forms as necessary to properly document the collection and transfer of the samples to the analytical laboratory.

4. Upon completing the chain-of-custody forms, forward two copies to the analytical laboratory and retain one copy for the field records.

Handling Procedures

1. After completing the sample collection procedures, record the following information in the field notebook with indelible ink:

- Project number and site name
- Sample identification code and other sample identification information, if appropriate
- Sampling method
- Date
- Name of sampler(s)
- Time
- Location (project reference)
- Location of field duplicates and both sample identifications
- Locations that field QC samples were collected including equipment blanks, field blanks and additional sample volume for matrix spikes
- Miscellaneous comments relevant to sample handling or processing

2. Complete the sample label with the following information in indelible ink:

   - Sample type (e.g., surface water)
   - Sample identification code and other sample identification information, if applicable
   - Analysis required
   - Date
   - Time sampled
   - Initials of sampling personnel
   - Sample matrix
   - Preservative added, if applicable

3. Cover the label with clear packing tape to secure the label onto the container and to protect the label from liquid.

4. Confirm that all caps on the sample containers are secure and tightly closed.

5. In some instances it may be necessary to wrap the sample container cap with clear packing tape to prevent it from becoming loose.

6. For some projects individual custody seals may be required. Custody seal evidence tape may be placed on the shipping container or they may be placed on each sample container such that the cooler or cap cannot be opened without breaking the custody seal (exception: do not apply custody seals to individual 40-mL vials). The custody seal should be initialed and dated prior to relinquishing the samples.

Packing Procedures

Following collection, samples must be placed on wet ice to initiate cooling to 4°C immediately. Retain samples on ice until ready to pack for shipment to the laboratory.

1. Secure the outside and inside of the drain plug at the bottom of the cooler being used for sample transport with “Duct” tape.

2. Place a new large heavy duty plastic garbage bag inside each cooler.

3. Place each sample bottle wrapped in bubble wrap inside the garbage bag.
   VOC vials may be grouped by sample in individual resealable plastic bags). If a cooler temperature blank is supplied by the laboratory, it should be packaged following the same procedures as the samples. If the laboratory did not include a temperature blank, do not add one. Place 1 to 2 inches of cushioning material at the bottom of the cooler.

4. Place the sealed sample containers upright in the cooler.

5. Package ice in large resealable plastic bags and place inside the large garbage bag in the cooler. Samples placed on ice will be cooled to and maintained at a temperature of approximately 4°C.

6. Fill the remaining space in the cooler with cushioning material such as bubble wrap. The cooler must be securely packed and cushioned in an upright position and be surrounded (Note: to comply with 49 CFR 173.4, filled cooler must not exceed 64 pounds).

7. Place the completed chain-of-custody record(s) in a large resealable bag and tape the bag to the inside of the cooler lid.

8. Close the lid of the cooler and fasten with packing tape.

9. Wrap strapping tape around both ends of the cooler.

10. Mark the cooler on the outside with the following information: shipping address, return address, “Fragile, Handle with Care” labels on the top and on one side, and arrows indicating “This Side Up” on two adjacent sides.

11. Place custody seal evidence tape over front right and back left of the cooler lid, initial and date, then cover with clear plastic tape.

Note: Packing Procedure numbers 2, 3, 5, and 6 may be modified in cases where laboratories provide customized shipping coolers. These cooler types are designed so the sample bottles and ice packs fit snugly within preformed styrofoam cushioning and insulating packing material.

Shipping Procedures

1. All samples will be delivered by an express carrier within 48 hours of sample collection. Alternatively, samples may be delivered directly to the laboratory or laboratory service center or a laboratory courier may be used for sample pickup.

2. If parameters with short holding times are required (e.g., VOCs [EnCore™ Sampler], nitrate, nitrite, ortho-phosphate and BOD), sampling personnel will take precautions to ship or deliver samples to the laboratory so that the holding times will not be exceeded.

3. Samples must be maintained at 4°C ± 2°C until shipment and through receipt at the laboratory.

4. All shipments must be in accordance with DOT regulations and T&M dangerous goods shipping SOPs.

5. When the samples are received by the laboratory, laboratory personnel will complete the chain-of-custody by recording the date and time of receipt of samples, measuring and recording the internal temperature of the shipping container, and checking the sample

identification numbers on the containers to ensure they correspond with the chain-of-custody forms.

Any deviations between the chain-of-custody and the sample containers, broken containers, or temperature excursions will be communicated to T&M immediately by the laboratory.

Data Recording and Management

Chain-of-custody records will be transmitted to the T&M PM or designee at the end of each day unless otherwise directed by the T&M PM. The sampling team leader retains copies of the chain-of-custody forms for filing in . the project file. Record retention shall be in accordance with project requirements.

Quality Assurance

Chain-of-custody forms will be legibly completed in accordance with the applicable project documents such as Sampling and Analysis Plan (SAP), Quality Assurance Project Plan (QAPP), Work Plan, or other project guidance documents. A copy of the completed chain-of-custody form will be sent to the T&M Project Manager or designee for review.

SOP #15:
Soil Sampling (Surface, Subsurface and Soil Boring)

Introduction

This guideline is to provide general reference information on soil sampling.

Limitations

These procedures apply to all soil sampling activities except for those particular requirements detailed in the project-specific plans for soil sampling.

Definitions

Composite Sample. A non-discrete soil sample composed of more than one specific aliquot collected at various locations.

EnCore sampler. The EnCore® sampling device is designed to facilitate soil sample collection with minimal handling by field personnel. The EnCore® sampler is used for collection, storage, and delivery of soil samples. It is a disposable, self-contained sampler, and thus is ideal for the collection of soils containing volatile organic compound (VOC) concentrations. In accordance with U.S. EPA SW-846 Method 5035, soil samples collected with the EnCore® sampler do not require field preservation if received and preserved by an analytical laboratory within 48 hours of sample collection. Soil samples collected using the EnCore® sampler shall be collected in compliance with the "Generally Acceptable Procedure for Soil Sampling with an EnCore Sampler. U.S. EPA SW-846 Method 5035 provides other methods of soil VOC sample collection (i.e., methods using field preservation), which may be used as provided in a project-specific plan. Soil VOC samples shall not be composited. Collection of soil VOC samples should be completed as soon as possible after recovery of soil material. The VOC sample should be collected from an undisturbed portion of the soil.

Environmental Samples. Samples with mid- or low-concentration contamination, such as samples collected from stained soils or samples collected along contaminant migration routes, that are collected at some distance from direct sources of contaminants.

Grab Sample. A discrete soil sample representative of a specific location at a given point in time.

Hand Auger. A hand auger consists of a T-handle attached to a stainless steel bucket (generally 2- to 4-inches diameters) with an attached cutting edge that is twisted downward into the soil. The stainless steel bucket allows for collection of subsurface soils during augering.

Soil Samples. Environmental samples of potentially contaminated soil, where soil is defined as a layer of weathered, unconsolidated material; often defined as containing organic matter and being capable of supporting plant growth.

Soil Trier. A typical sampling trier consists of a long stainless steel tube with a slot that extends almost its entire length. The tip and edges of the tube slot are sharpened to allow the trier to cut a core of the soil to be sampled when rotated after insertion into the ground.

Split-Spoon. The split-spoon sampler is a thick-walled steel tube that is split lengthwise. A cutting shoe is attached to the lower end; the upper end is connected to drill rod. The sampler is driven 18 to 24 inches into the ground, depending on the length of the split spoon, to collect the sample in accordance with a standard penetration test (ASTM D1586).

Transfer Device. Any instrument or vessel that contacts the sample during collection or transport (e.g., stainless steel trowel).

Guidelines

Soil types at a hazardous waste site can vary considerably, both at the site surface and in the underlying strata. Soil variations affect the rate of contaminant migration via surface runoff and windblown transport of particulates, and affect the rate of contaminant migration downward through the soil. Sampling of the soil horizons above the ground water table can detect contaminants before they have migrated into the groundwater, and can help to quantify the amount of contaminants contained in the soil that have the potential to contribute to groundwater contamination.

The physical properties of soil (e.g., grain size, cohesiveness, and moisture content) and the depth to groundwater may limit the depth from which soil samples can be collected and dictate the required methods for sample collection. In order to predetermine the suitability of a chosen sampling method to soil conditions, information pertaining to regional soil properties should be obtained from either the U.S. Department of Agriculture, Soil Conservation Service or from published soil surveys by the U.S. Geological Survey (USGS). One of several applicable soil sampling techniques should then be selected to collect on-site samples.

Most of the methods employed for soil sampling at hazardous waste sites are adaptations of techniques long employed by foundation engineers and geologists. Collection of samples from near the soil surface can be accomplished by using a trowel, thin-walled tube sampler, or soil trier. Shallow subsurface soils can be sampled using hand augers. However, the collection of soil samples from the deeper subsurface strata normally requires heavy equipment, such as a truck-mounted drill rig employing split-spoon sampling.

The following method may be employed for the recovery of soil materials at hazardous waste sites:

1. Stainless steel trowel and/or scoop/scoopula
2. Soil trier
3. Hand auger
4. Split-barrel sampler, soil core, or similar device

The preferred order of sample collection is:

1. Volatile Organic Compounds (VOCs)
2. Semi-Volatile Organics (SVOCs)
3. Metals
4. Other Inorganics
5. Radionuclides

Homogenization Procedure for the Collection of Non-VOC Surface Soil Samples

Note: This procedure should be followed for all types of soil sampling (i.e., grab and composite).

1. Thoroughly mix the sample using the same stainless steel trowel or scoop used during the sample collection. The soil in the bowl should be scraped from the sides, corner, and bottom, rolled to the middle of the bowl and initially mixed.

2. The sample should be quartered and separated.

3. Each quarter should be mixed individually and then rolled to the center of the bowl.

4. Mix the entire sample again.

Procedure For Surface Soil Grab Sampling Using A Stainless Steel Trowel and/or Scoop/Scoopula.

1. For VOC samples, dig a hole to the desired depth with the trowel or scoopula. Remove surface vegetation, debris or large stones. Use the EnCore® samplers to collect the soil sample (from an undisturbed area) for VOA analysis.

2. For non-VOC sample fractions, insert the stainless steel trowel or scoop into the soil at a depth of 0 - 2 inches and remove the sample, avoiding the collection of surface vegetation, debris and large stones. Place the sample volume collected in a stainless steel bowl and homogenize the soil.

3. Transfer the homogenized non-VOA fraction into the appropriate sample containers using the same stainless steel trowel or scoop used throughout this entire procedure.

4. Restore the void created by sample collection prior to leaving the sampling location (if necessary commercially available potting soil or top soil may be used to fill the void).

Procedure For Surface Soil Composite Sampling Using A Stainless Steel Trowel and/or Scoop/Scoopula.

1. There will be no composite samples collected for VOA analysis.

2. For non-VOA sample fractions, insert the stainless steel trowel or scoop into the soil at a depth of 0 - 2 inches and remove the sample, avoiding the collection of surface vegetation, debris and large stones. Place the sample volume collected in a stainless steel bowl, follow this procedure for each aliquot collected at the various locations or at different points in time (whichever is applicable).

3. Composite the non-VOA soil sample aliquots in the stainless steel bowl. Then follow the procedure for homogenization (refer to page 3 of this SOP).

4. Transfer the homogenized non-VOA fraction into the appropriate sample containers using the same stainless steel trowel or scoop used throughout this entire procedure.

5. Restore the void created by sample collection prior to leaving the sampling location (if necessary commercially available potting soil or top soil may be used to fill the void).

6. Decontaminate the exterior of the sample container. Refer to the Field Decontamination SOP.

Procedure for Surface or Subsurface Soil Sampling Using A Soil Trier

Trier samplers are ideal for the collection of undisturbed samples from cohesive soils, especially silts and clays. Procedures for use of the soil trier sampler are as follows.

1. Clean the stainless steel soil trier according to the requirements for the analytical parameters being measured.

2. Force the soil trier into the soil with a single smooth motion until the top of the trier tube is even with the soil surface.

3. Rotate the trier once or twice to cut a core of the soil, then carefully withdraw the trier to collect the undisturbed soil sample.

4. First collect the VOA fraction of the soil sample from the trier by using the EnCore® samplers to collect the soil samples. Collect the EnCore sample from an undisturbed portion of the soil.

5. Place the remaining non-VOA sample fractions in a stainless steel mixing bowl. Repeat the sampling procedure until sufficient sample quantity has been collected, and homogenize the soil.

6. Transfer the homogenized soil into the appropriate sample containers using the same stainless steel trowel or scoop used throughout this entire procedure.

7. Restore the void created by sample collection prior to leaving the sampling location (if necessary commercially available potting soil or top soil may be used to fill the void).

Procedure for Sub-Surface Soil Sampling Using A Hand Auger

Hand augers are ideal for collecting shallow subsurface soils in cohesive soils such as silts and clays. In cohesive soils, a hand auger can be used to collect samples generally up to a depth of 3 feet. However, in rocky soils auger refusal is experienced almost immediately, as small stones will block and jam the cutting edge on the auger bucket. Procedures for use of the hand auger are as follows.

1. Hand augers should not be used to collect soil samples for VOC analysis.

2. Clean the stainless steel hand auger according to the requirements for the analytical parameters being measured.

3. Clear the area to be sampled, removing any surface vegetation, debris, or large stones prior to augering.

4. Begin augering. When the auger is filled, carefully withdraw it from the borehole and remove the soil from the auger by lightly tapping the side of the bucket with a stainless steel trowel.

5. Continue augering following the above procedure, until you have reached the desired sampling depth.

6. Place the soil to be sampled in a stainless steel mixing bowl. Repeat the sampling procedure until sufficient sample quantity has been collected. Homogenize the soil sample.
7. Transfer the homogenized soil into the appropriate sample containers using the same stainless steel trowel or scoop used throughout this entire procedure.

8. Restore the void created by sample collection prior to leaving the sampling location (if necessary commercially available potting soil or top soil may be used to fill the void).

Procedure for Soil Boring Sampling Using a Split-Spoon or Core

The collection of split-spoon samples or cores normally requires the use of a drilling rig or hydraulic rig (e.g., geoprobe). To collect a split-spoon (or split-barrel) sample, a boring is advanced to the sampling point, drill tools are removed and a 2-inch I.D. steel split-spoon is threaded onto the drill rods and lowered to the bottom of the borehole. In accordance with the standard penetration test (ASTM D1586), the split-spoon is driven downward into the soil beneath the lead flight of augers by a 140-lb hammer falling 30 inches. The number of blows that are required to drive the split spoon each 6-inch interval is counted and recorded. The density of the soil material is determined by the number of blows per foot. The split-spoon is then withdrawn from the borehole, dismantled, and given to the field geologist for sampling and analysis.

If using continuous core, the drilling rig (or earthprobe rig) will hydraulically push a core barrel through the soil column. With most standard Geoprobe® rigs, the soil will collect in a plastic

sleeve, typically 5-feet long, though other sizes are available, which is then retrieved for logging, screening, and/or sampling.

Whether the sample device is a split-spoon, thin-wall, core barrel, or plastic sleeve, the procedures for sampling are basically the same once the sampler is opened:

1. Remove the head and carefully open the halves of the split-spoon. If sampling with a core from a hydraulic (geoprobe) rig, carefully cut the plastic sleeve open using the manufacturer's specialized cutting tool or box cutter.

2. Immediately collect the soil VOC fraction from an undisturbed portion of the soil using the EnCore® samplers. (To determine which portion of the core to collect, consult the site specific SAP and QAPP.)

3. Log the soil core using Unified Soil Classification System or other classification system as required.

4. Place the remaining soil (for non-VOC sample fractions) in a stainless steel mixing bowl.

5. Homogenize the remaining soil, and place the homogenized non-VOC fraction soils into the appropriate sample containers using the same stainless steel trowel or scoop used throughout this entire procedure.

References

ASTM D1452. Standard practice method for soil investigation and sampling by auger borings. American Society for Testing and Materials, Philadelphia, Pennsylvania. June 12, 1980.

ASTM D1586. Standard method for penetration test and split-barrel sampling of soils American Society for Testing and Materials, Philadelphia, Pennsylvania. September 11, 1984.

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SOP #16A:
Soil Sampling with an EnCore® Sampler

Purpose/Application

The EnCore® sampling device is designed to facilitate soil sample collection with minimal handling by field personnel. The EnCore® sampler is used for collection, storage and delivery of soil samples. It is a disposable, self-contained sampler, and thus is ideal for the collection of soils containing volatile organic compound (VOC) concentrations. In accordance with USEPA SW-846 Method 5035, soil samples collected with the EnCore® sampler do not require field preservation if received and preserved by an analytical laboratory within 48 hours of sample collection. The EnCore® sampling device is most applicable for collection of cohesive soils, such as those containing clay or silt matrix material. The EnCore® sampler typically is not effective for collection of noncohesive soils, coarse gravels and till. Coarse sediment clasts also may not fit inside the sampler coring body. The soil sample should be collected from an undisturbed area of the soil.

Recommended Equipment

- Disposable EnCore® sampler (5 g).
- Standard EnCore® T-handle.
- Protective gloves.

Equipment Decontamination Procedures

The sampler is disposable, therefore no decontamination is necessary. The T-handle can be cleaned with low phosphate detergent (Alconox or equivalent) and water.

Procedures

Before Taking Sample:

1. Hold coring body and push plunger rod down until small o-ring rests against tabs (Figure 1). This will ensure that plunger moves freely.

2. Depress locking lever on EnCore® T-handle. Place coring body, plunger end first, into open end of T-handle, *aligning the (2) slots on the coring body with the (2) locking pins in the T-handle*. Twist coring body clockwise to lock pins in slots. Check to ensure sampler is locked in place. Sampler is ready for use.

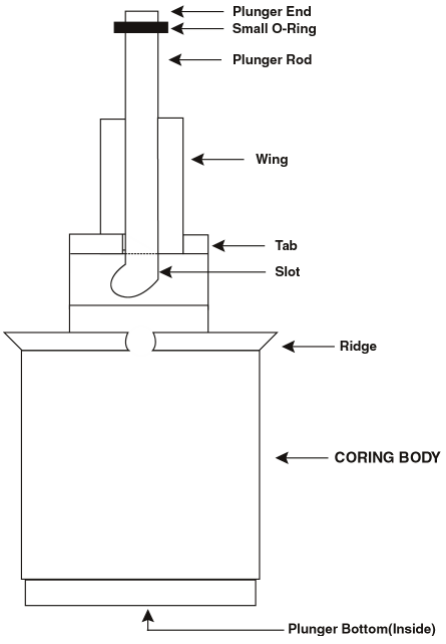

Figure 1. EnCore® Sampler.

Taking Sample:

3. Turn T-handle with T-up and coring body down (Figure 2). This positions the plunger bottom flush with bottom of coring body (ensure that plunger is in position). Using T-handle, push sampler into soil until coring body is completely full. When full, small o-ring will be centered in T-handle viewing hole. Wipe excess soil from sampler. Wipe excess soil from coring body exterior.

4. Cap coring body while it is still on T-handle. Push cap over flat area of ridge (Figure 3). ***Push and twist cap to lock arm in place. Cap must be seated to seal sampler.***

5. To ensure sufficient sample volume, collect three EnCore® samples for each sample point. Should the sampling and analysis plan (SAP) request it, two 5 gram EnCore® samples should be collected per sample location for VOCs and 2 additional 5 gram EnCore® samples should be collected for GRO.

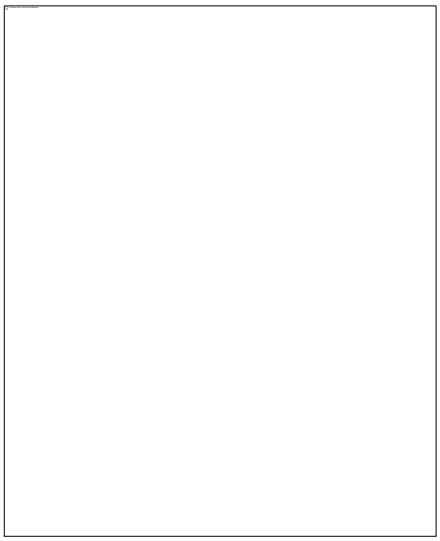

Figure 2. EnCore® T-Handle.

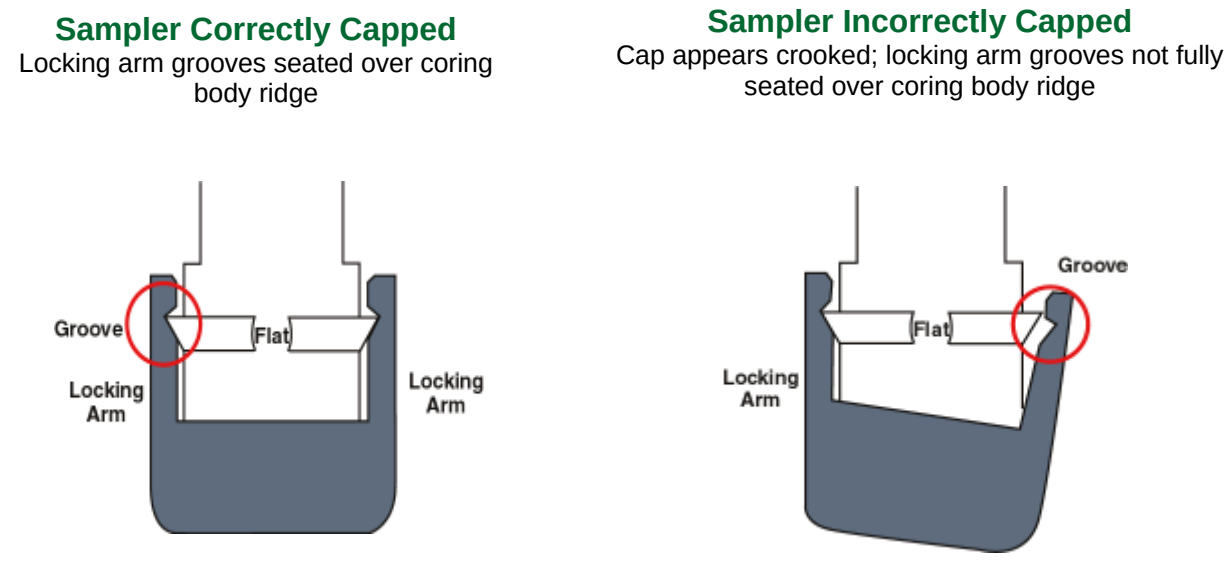

Figure 3. The EnCore® sampler capped correctly and incorrectly.

Preparing Sampler for Shipment:

6. Remove capped sampler by depressing locking lever on T-handle while twisting and pulling sampler from T-handle.

7. Lock plunger by rotating extended plunger rod fully counter-clockwise until wings rest firmly against tabs (Figure 4).

8. Attach completed label to cap on coring body.

9. Return EnCore® Sampler to zipper bag. Seal bag and put on ice.

10. Samples must be received and preserved at an analytical laboratory within 48 hours of collection.

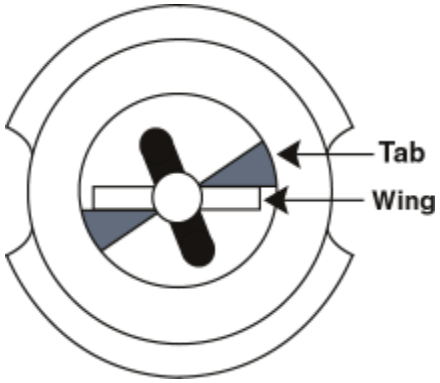

Figure 4. Plunger in locked position with wings resting firmly against tabs.

REFERENCES

All procedures provided by: En Novative Technologies, Inc.
http://www.ennovativetech.com/encore/sampling.htm

USEPA SW-846 Method 5035 can be downloaded at:
http://www.epa.gov/epaoswer/hazwaste/test/pdfs/5035.pdf

SOP #16B:
Soil Sampling with a Terra Core® Sampler

Purpose/Application

The Terra Core® sampling device is a single-use sampler, designed to collect soil samples and transfer them to appropriate containers for shipment to the laboratory. It is a disposable transfer tool for the collection of soils containing volatile organic compound (VOC) concentrations. In accordance with USEPA SW-846 Method 5035 and 5035A, soil samples collected with the Terra Core® sampler may be transferred to unpreserved 40-mL glass vials if received and preserved or frozen by an analytical laboratory within 48 hours of sample collection; alternatively, vials may be pre-preserved with sodium bisulfate (to pH < 2) for low-level VOC analyses or methanol for high-level VOC analyses. The Terra Core® sampling device is most applicable for collection of cohesive soils, such as those containing clay or silt matrix material. The Terra Core® sampler may not be effective for collection of noncohesive soils, coarse gravels and till. Coarse sediment clasts also may not fit inside the sampler coring body. The soil sample should be collected from an undisturbed area of the soil.

Recommended Equipment

- Disposable Terra Core® sampler. Use a 5 g sampler for standard VOCs, BTEX/MTBE, or TPH-GRO. A 10 g sampler may be used for site-specific instances, such as analyses for TPH-TX 1005.
- Sample containers, as applicable with the Sampling and Analysis Plan:
  - 2 40-mL glass vials, either unpreserved (with magnetic stirring rod) or pre-preserved with sodium bisulfate (low-level analyses)
  - 1 40-mL glass vial, either unpreserved or pre-preserved with methanol (high-level analyses)
  - 1 40-mL or 60-mL glass vial, unpreserved (for moisture content)
- Protective gloves.

Equipment Decontamination Procedures

The sampler is disposable, therefore no decontamination is necessary.

Figure 1. Terra Core® Sampler pushed into freshly exposed Soil.

Procedures

1. Have ready a 40-mL glass VOA vial containing the appropriate preservative. If practical (see site-specific Sampling and Analysis Plan), weigh vials pre-preserved with methanol on the day of sampling to ensure that no solvent has been lost since container preparation; vials should be within 0.01 g of the laboratory-recorded tare weight.

2. With the plunger seated in the handle, push the Terra Core® into freshly exposed soil until the sample chamber is filled. A filled chamber will deliver approximately 5 or 10 grams of soil.

3. Wipe soil or debris from the outside of the Terra Core® sampler. The soil plug should be flush with the mouth of the sampler. Remove any excess soil that extends beyond the mouth of the sampler.

4. Rotate the plunger that was seated in the handle top 90° until it is aligned with the slots in the body. Place the mouth of the sampler into the 40-mL VOA vial and extrude by pushing the plunger down.

5. Quickly place the lid back on the 40-mL VOA vial. When capping the vial, be sure to remove any soil or debris from the top and/or threads of the vial.

6. Put the vial in a sealable plastic bag and place in a cooler of ice. Unpreserved vials must be frozen or preserved by the laboratory within 48 hours.

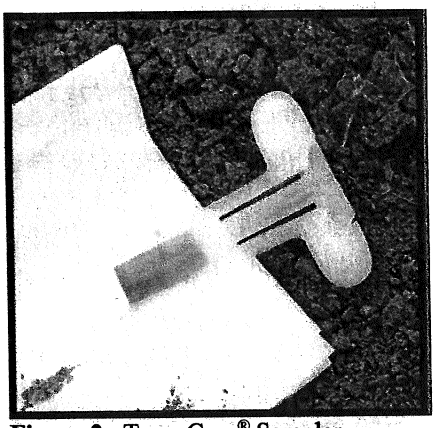

Figure 2. Terra Core® Sampler chamber filled with soil sample.

Figure 3. The Terra Core® sampler transferring sample to a 40-mL vial.

REFERENCES

All procedures provided by: En Novative Technologies, Inc.
http://www.ennovativetech.com/files/TerraCoreUseDirections.pdf

USEPA SW-846 Method 5035 can be downloaded at:
http://www.epa.gov/epaoswer/hazwaste/test/pdfs/5035.pdf

Ohio EPA FSOP 2.1.7 (May 17, 2012) for Soil Sample Collection for Volatile Organic Compound Analysis Compliant with U.S. EPA SW-846 Methods 5035 and 5035A:
http://epa.ohio.gov/portals/30/rules/FSOP%202.1.7%20VOC%20Soil%20Sampling%20(5035%20Methods)%205-17-12%20FINAL.pdf

SOP #17:
Temperature Measurement

Purpose/Application

The purpose of this procedure is to outline a procedure for personnel on how to perform a temperature measurement. Temperature measurements are carried out with a temperature probe. In addition the procedure will talk about the calibration procedure for the temperature probe.

Recommended Equipment

- Temperature Probe

Procedures

Temperature Testing Procedure:

Temperature is usually measured during a combined test with pH and conductivity.

Calibration Procedure:

The test probe will be checked biannually for calibration, by immersing it with a reference thermometer in a bath of known temperature until equilibrium is reached. The thermometer will not be used if it is found to have more than 10% error. The reference thermometer used will be a NIST-approved thermometer.

SOP #18:
Turbidity Measurement

Purpose

This guideline details the steps required to measure the turbidity of groundwater while in the field. This guidance is applicable to all aqueous samples such as potable well water, monitoring well water, surface water, and other water samples.

Turbidity meters (also referred to as turbidimeters or nephelometers) are highly sensitive meters which measure the amount of suspended solids in a water sample. Turbidity meters have a linear and direct response to increases in turbidity; a light beam enters the sample through the bottom of the sample cell and passes up through the sample into the light shield. As light passes through the sample, some light is scattered by turbidity in the sample. The portion of the light that scatters at 90 degrees is sensed by the photocell thereby eliciting a numerical reading on the instrument display. The meter scale is calibrated in nephelometric turbidity units (NTU) to provide direct turbidity readouts.

Definitions

Turbidity – Turbidity refers to solids and organic matter that do not settle out of water. Turbidity is measured by how much light is transmitted or scattered when a beam of light is passed through a water sample.

Sample Cells – The sample cells are 18x15 mm, Pyrex glass, and are filled with the water sample to be analyzed.

Turbidity Standards – Secondary standards used to standardize/calibrate the turbidity meter.

Nephelometric Turbidity Units (NTU) – The measurement of light that scatters at a 90° or 270° angles to the incident light beam.

Equipment

The following equipment is needed to measure the turbidity of a water sample:

1. Portable turbidimeter

Procedures

Turbidimeters differ as to specifics of use. Follow the manufacturer's instructions to obtain an accurate reading. The following general steps should be used to measure the turbidity of a water sample:

1. Calibrate the turbidity meter in accordance with the manufacturer's directions. Use both the 1 and 10 NTU calibration standards.

2. Fill a clean sample cell to the white line with the sample to be measured. Dry the sample cell with a clean cloth or paper towel. Place the cell into the instrument. Use the white dot, arrow or other indicator on the sample cell to orient the cell in the correct position. Close the light shield and press the "Read" button.

References

Groundwater and Wells, Second Edition. Johnson Filtration Systems, Inc., St. Paul, Minnesota, 1986.

SOP #35:
Groundwater Sampling – Packer Method

Purpose/Application

The purpose of this document is to provide general reference information for vertical profile groundwater sampling using a packer assembly.

Recommended Equipment

Multi-parameter water quality monitoring system, such as a Horiba or YSI.

Graduated cylinder and stopwatch for flow rate measurement.

Peristaltic Pump. A positive displacement rotary pump with a roller or shoe that squeezes a flexible tubing or hose as it rotates. The squeezing action draws groundwater from a monitoring well through the tube. Groundwater only comes in contact with the dedicated well tubing, allowing for consistent sample integrity.

Electronic Water Level Indicator. An electronic water level indicator is used to measure the depth to water in a well from an established point, usually the top of well casing (TOC). The electronic water level indicator consists of a ruled electrical cable and a contact electrode. When the electrode contacts groundwater, an electronic circuit is completed that emits a sound and lights a light bulb. Upon contact, the depth to groundwater is read directly from the ruled electrical cable.

Packer Assembly

- ½-inch diameter packer assembly with desired screen length (sample interval),
- ½-inch outside diameter (OD) x 3/8-inch inside diameter (ID) polyethylene tubing (new) of sufficient length to reach the desired sample interval,
- Tubing clamp or plastic zip-ties to aid in attachment of the tubing to the barbed fitting on the packer assembly.

Tubing - Inert tubing should be chosen based on the types and concentrations of contaminants present, or expected to be present, in the monitoring well. Polyethylene or Teflon® tubing can be used when sampling for volatile, semivolatile and inorganic constituents. Each monitoring well must utilize dedicated tubing to prevent cross-contamination between sampling locations.

Flexible Tubing – Flexible tubing, such as silicone, is needed for operation of the peristaltic pump. Each monitoring well should have a dedicated piece of flexible tubing to prevent cross-contamination between sampling locations.

Decontamination supplies – Distilled water and any solvents (if used). Pressure sprayers/spray bottles, 5-gallon buckets with lids, brushes and non-phosphate soap also will be needed.

Procedures

Groundwater sample collection from monitoring locations on or near hazardous waste sites may be required to document the release of a hazardous substance or petroleum to the environment, or to track the contaminant fate and transport over time. Horizontal and vertical contaminant distribution profiles are helpful in understanding site-wide contamination. A packer assembly can be used to isolate screened sections within a fully-screened or partially-screened monitoring well. Isolation of screened sections allows vertical groundwater profiling of an aquifer without the need for multilevel monitoring wells. Using a packer assembly, each isolated screened section can be sampled and analyzed with low-flow sampling techniques to obtain samples representative of the aquifer at the sampled elevation of the screen.

Packer Assembly

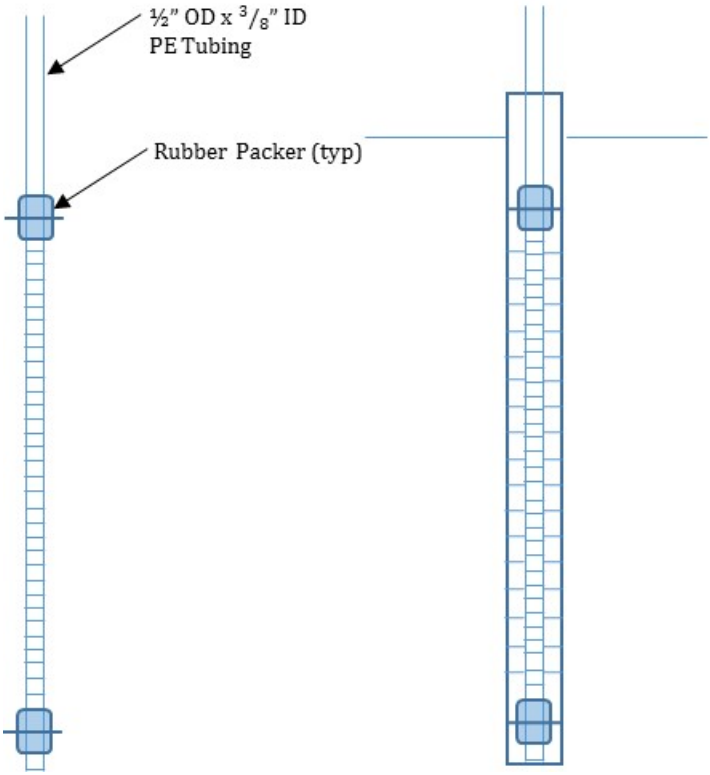

Figure 1: Packer Assembly

Removable packer systems, like the one shown in Figure 1, can be used in standard 1-inch monitoring wells. Assembly and placement of the packer system is as follows:

1) Attach the ½" OD x 3/8" ID polyethylene (PE) tubing to a new or decontaminated packer assembly.
2) Ensure that the PE tubing is sufficiently long to allow the packer assembly to reach the desired depth within the 1-inch well screen.
3) Mark off the length of PE tubing needed to reach the desired depth in the well.

4) After measuring the initial static water level in the monitoring well, lower the packer assembly (attached to the PE tubing) to the desired/marked sampling depth. To minimize investigation-induced cross contamination in the monitoring well, sampling should be conducted from the top of the screen of the monitoring well to the bottom, if multiple depth intervals are being sampled.

Well Purging and Stabilization

Prior to collection of groundwater samples from a monitoring well, three to five volumes of standing water must be purged to ensure that the samples collected are representative of the groundwater conditions in the aquifer. During purging, field parameters are monitored to inform field personnel when the conditions are stable for sample collection. Purging should occur at a low rate to minimize the pull of groundwater across the packers through the sand pack or aquifer surrounding the 1-inch well.

Determine the Volume of Standing Water in a Monitoring Well

The procedure for determining the volume of standing water in a monitoring well is as follows:

1. Clean all down-hole equipment according to all established decontamination procedures.

2. Measure the depth to groundwater from the measuring point on the top of the well casing.

3. Note the diameter of the well and determine the radius.

4. Determine the depth of the water column by subtracting the depth to the bottom of the packer system from the depth to groundwater.

5. Determine the volume of standing water in the well. Use a 1-inch diameter for the water column in the packer assembly. Use a 3/8-inch diameter for the remaining water column.

6. Multiply the volume of standing water in the well by 3 to 5 to calculate the required minimum purge volume.

Groundwater Stabilization

Monitoring wells are purged to remove stagnant water from the well casing so representative "formation" water will flow into the well for sampling. During purging, groundwater parameters are monitored to determine when the water extracted contains primarily water entering the well directly from the formation. The most common indicator parameters are temperature, pH, and conductivity (specific conductance). Of these three, temperature is considered the least important, as it is susceptible to "noise" from the current weather conditions. Additional stabilization parameters that may be included on a site-by-site basis include turbidity and dissolved oxygen.

The procedure for purging and stabilizing is as follows:

1) Connect the ½-inch OD PE tubing to the flexible tubing of the peristaltic pump.
2) Start the pump and determine the flowrate from the well using a graduated cylinder (or similar). The purge rate will vary from well to well and within vertical intervals within a given well. Unless otherwise directed, field personnel should collect all purge water pumped from the well.
3) Continue pumping and monitor the field parameters with the water quality meter. Each monitoring well should be purged until indicator parameters stabilize over at least three successive readings collected at approximately 5-minute intervals during pumping[1]. The time interval is dependent on the pumping rate and may vary.
4) Record each parameter during purging. The well is considered stabilized once field parameters meet the criteria presented in Table 1.
5) Record the total volume of groundwater purged. The volume can be determined by multiplying the flow rate by the total purge time.
6) Once conditions have stabilized, sample collection can proceed.
7) Move the packer up to the next screened interval for additional sample collection.
8) Once all samples are collected from the monitoring well, transfer purge water to 55-gallon drums for proper disposal.

Table 1: Groundwater Stabilization Criteria

Parameter	Acceptable Range	Comment
Temperature	±0.5 °C	If possible; least important and reliable parameter for stabilization
pH	±0.1 SU	May not stabilize with bailers or other purging methods that may disturb (aerate) the groundwater; not particularly sensitive to stagnant vs. formation water
Specific Conductance (Conductivity)	±3%	
Turbidity	±10%	Or <10 NTU, if possible; not particularly sensitive to stagnant vs. formation water

Sample Collection

Once the monitoring well has been purged, groundwater samples can be collected. Groundwater samples should be collected in order of their volatility, with the VOA fraction collected within 3 hours following initial purging. However, samples should generally be collected without

1 Typically three to five well volumes are purged before conditions stabilize. However, if five well volumes have been purged and parameters are not stable, field equipment should be checked and re-calibrated if necessary. In general, five well volumes is considered sufficient to ensure that formation water is entering the well screen, despite unstable field parameters. Field personnel should use their judgement to decide whether conditions are suitable for sample collection.

interruption of the low flow purging stream without interruption. Samples for parameters not subject to loss through volatilization, like metals, should be collected last.

The following considerations should be made before and during groundwater sampling activities:

A. All equipment placed in the well should be clean.

B. New outer gloves must be donned before sampling or handling clean equipment.

C. Containers/bottles provided by the laboratory should be checked. Correct sample containers and preservatives are needed for accurate laboratory data.

D. The Certified Professional will determine the analyte list and analysis methods and will include this information in the Sampling and Analysis Plan (SAP). Sample collection order should proceed in the following way, unless otherwise stated in the SAP:

1. Volatile Organic Compounds (VOCs)
2. Semi-Volatile Organic Compounds (SVOCs)
3. VAP Metals/Inorganics
4. Dissolved Metals/Inorganics
5. Sulfate, Chloride, TDS, Alkalinity, Turbidity (if not measured in the field)
6. Nitrate/Nitrite and Ammonia
7. Cyanide
8. Turbidity
9. Radionuclides

This sampling method should repeated for each vertical interval sampled using the packer.

Decontaminating the Packer Assembly

The packer assembly may be reused if properly decontaminated. Once removed from the well, it should be decontaminated with a non-phosphate soapy-water wash and scrubbed with a brush, rinsed with tap water, and then rinsed with distilled water to prevent cross-contamination between wells. The step-by-step procedure is as follows:

1) Line up 4 5-gallon buckets:
   - Fill one with non-phosphate soap and tap water
   - Fill one with tap water
   - Fill one with distilled water
   - Keep one empty to collect decon water.
2) Remove the packer assembly from the monitoring well and disconnect the ½-inch OD tubing. Discard the tubing in a manner appropriate with site IDW handling practices.
3) Place one end of the pipe in the empty bucket and pour soapy-water wash on the outside and inside. Using a scrub brush, scrub the inside and outside to ensure contact between the decon solution and the pipe.
4) Spray/pour tap water over all surfaces of the pipe to rinse off the soap.

5) Pour distilled water over all surfaces of the pipe.
6) Use disposable paper towels to dry the pipe.
8) Transfer decon water to 55-gallon drums to be handled according to IDW protocol.

Notes for Filling VOC Vials:

Vials for the VOC analyses must be filled carefully to avoid trapping air bubbles. This is best accomplished by tilting the vial slightly so that sample water slowly flows down the inner edge of the vial. The sample tubing should not touch the vial. The vial should be filled until there is a positive meniscus above the rim and the cap then carefully screwed on. Invert the vial to verify that there are no air bubbles present. If air bubbles are trapped, attempt to eliminate by gently tapping the upright vial to force the bubbles to the top, remove the cap, and carefully top off the sample. If bubbles persist, then either re-collect the sample in a new (pre-preserved) vial or, in extreme cases where the preservative may be reacting and contributing to bubble formation, collect an unpreserved sample and note this on the label and chain-of-custody (unpreserved VOC samples have a 7-day holding time).

Notes for Field Filtering:

If the SAP requires filtering during sample collection, field personnel should use the following procedure:

1. If possible, use a positive-pressure, in-line filtering method with the sampling pump (or bailer, if it is equipped with a bottom-loading valve and can be pressurized with a hand pump).
2. If an "open" filtering system must be used, take care to minimize sample disturbance during transfer to an intermediate container before filtering. Open filtering should be done as soon as possible after sample collection and before preservation to minimize precipitation or degassing.
3. Use a disposable, inert filter with a minimum pore size of 0.45 microns (e.g., QED Quickfilter). Alternate pore sizes can be selected on a site-specific basis, but the filter pore size should not be finer than the largest mobile fraction of particulates anticipated in the formation.
4. Pre-rinse the filter to remove potential residue from the manufacturer. Flush with sample water to create a uniform wetting front.
5. Decontaminate or dispose filtration equipment (filter, tubing, etc.), as appropriate.

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SOP #36:
Temporary Groundwater Monitoring Well Installation
Upper Aquifer – Grenada Manufacturing Site, Grenada, MS

Introduction

This guide is to provide general reference information for the practice and documentation of temporary groundwater monitoring well installation in Grenada, MS.

Definitions

Borehole. An elongate, vertical void in the earth created by drilling (boring).

Over-drilling. A method of drilling into an existing borehole with augers or drill tooling of larger diameter.

Well Screen. A length of one or more segments of perforated pipe threaded together. The pipe perforations (slots) are large enough to permit free flow of groundwater and contaminants into a monitoring well and small enough to prevent the entrance of formation solids. Typically temporary ground water well screens are factory mill-slotted.

Screened Interval. The depth interval (measured positively and accumulatively from surface to depth) of the formation that is adjacent to the well screen.

Well Riser. A length of one or more segments of solid pipe threaded together extending from the well screen to the surface. The riser threads into the screen through flush threaded connection.

Monitoring Well. A subsurface construction consisting of a bottom cap affixed to a well screen and riser installed within a borehole that is stabilized and sealed with a filter pack around the well screen and well seal that prevents surface infiltration and/or communication from ground water zones above the filter pack. The well riser is capped with a removable well cap, typically an expanding J-plug type. A lockable protective riser, flushmount or protective steel pipe maybe installed to protect and secure the monitoring well.

Temporary Monitoring Well. A monitoring well that is not intended to be part of a permanent groundwater monitoring network.

Silty Clay Surficial Soil. Unconsolidated material dominated by clay and silt-size grains present at ground surface to approximately 15 feet below ground.

Shallow Zone – Upper Aquifer. A zone of saturated fine- to coarse-grained sand with some silt and clay components extending from approximately 15 to approximately 25 feet below ground.

Intermediate Clay. A zone of silty clay the separates the Shallow and Deep Zones of the Upper Aquifer. The Intermediate Clay is thinner and/or absent to the north and west. Its depth, where present, ranges between approximately 25 to 40 feet below ground. This unit serves as the terminus for wells screened in the Shallow Zone of the Upper Aquifer.

Deep Zone – Upper Aquifer. A zone of saturated fine- to coarse-grained sand with some silt and clay components between the overlying Intermediate Clay and the Shaley Clay Aquitard. The Deep Zone of the Upper Aquifer typically is encountered from approximately 40 to approximately 60 feet below ground.

Shaley Clay Aquitard. A lithologic unit of clay and shale that divides the Upper Aquifer from the Lower Aquifer. The unit is of very low vertical permeability and is considered an aquitard and/or a barrier to groundwater and other substances.

Field Logbook. A bound document with numbered pages used to maintain a chronological record of field activities and data in accordance with field and quality procedures.

Guidelines

Monitoring wells are installed within boreholes to obtain monitoring points for potentiometric surface measurements and groundwater sampling. Proper installation of monitoring wells is critical to achieve the following goals:

1. Prevent cross-contamination between groundwater zones.
2. Enable effective hydraulic connection between the monitoring well and the surrounding formation screened by the well.
3. Limit accumulation of formation solids in the well.

Temporary groundwater monitoring wells are installed to provide supplemental monitoring points in addition to the monitoring well network. Such temporary monitoring points may be used to:

- Determine the effectiveness of the groundwater network.
- Verify uncertainty in either the groundwater monitoring network or conceptual site model.
- Provide additional potentiometric control outside of areas where groundwater monitoring is required.

Soil sampling for Lithology and Stratigraphy

A boring is advanced at the intended temporary well location with direct push technology (DPT) or hollow-stem auger drilling methods. DPT drilling may utilize a Dual-Tube or Macrocore™ approach to the sampling of soils. These soil cores are retrieved from the boring in acetate sleeves, which are cut open to allow logging of the stratigraphy in accordance with the logging of a DPT boring SOP. In areas of good stratigraphic control, logging of temporary wells may be ceased once the Deep Zone of the Shallow Aquifer is verified, depending upon project work plans and investigation goals. When the boring has been logged to at least the depth of the Deep

Zone of the Upper Aquifer (allowing a determination of the presence/absence of the Intermediate Clay and the upper and lower bounds of this unit where present), the DPT tooling is changed to allow advancement of larger diameter rods into the boring created by the tools used for stratigraphic logging.

Well Installation

DPT rods with an internal diameter of at least 3 inches are advanced to the intended well screen total depth with an expendable stainless steel tip. Typically, the drilling of 3-inch inside diameter DPT rods is performed in the same borehole created for the sampling of soils for lithology and stratigraphy. For continually screened wells in the Upper Zone of the Shallow Aquifer, this is the top of the Intermediate Clay. For continually screened wells in the Deep Zone of the Upper Aquifer, this is the base of the Deep Zone/ top of the Shaley Clay Aquitard. The depth at which the Shaley Clay Aquitard is encountered is relatively consistent across the site and can be approximated from nearby borings that have been advanced to this unit. Contact with the Shaley Clay Aquitard is accompanied by drilling refusal with standard DPT methods.

Placement of Well Materials

All well materials to be installed per this procedure are to be new, in their original factory packaging and visually inspected as to suitability for use.
The well screen and riser sections are flush-threaded together while lowering the well material into the large-diameter DPT rods.

The well screen will consist of one-inch diameter, schedule 40 PVC with 0.010-inch machined slots, per ASTM standard F480-14. A bottom cap will be attached to the bottom of the well screen. If the screen placement is such that the desired screen length is not an even screen joint length, the base section of screen is cut to the appropriate length and a slip cap is placed on the base of the lowest screen section. The slip cap is not glued to the PVC pipe, but remains in place due to friction. If the screen length is an even interval of 5-feet, the base of the well includes a threaded cap that threads into the internal threads of the screened riser.

One-inch diameter, internally-threaded, schedule 40 PVC riser is threaded onto the top of the highest length of screen material. Additional riser is threaded to the well string as it is lowered in the DPT rods until the riser extends to or above the ground surface. A well cap is installed to top of the well string to prevent annular materials from entering the temporary groundwater monitoring well.

When the well materials are fully constructed within the DPT rods, the rods are pulled upward with the DPT rig while the well material is held in place. This process results in detachment of the expendable tip at the base of the rod. The rods are vibrated during withdrawal, to a height of approximately 1 to feet above the top of the well screen, to aid natural collapse of the formation against the well screen. The driller shall periodically check the elevation of natural collapse relative to the top of well screen and the bottom of DPT rods with a clean, weighted tape). If

natural-collapse no longer fills the annular space around the well screen, washed silica sand, appropriately sized for the screen slot size, is installed through the DPT rods to filling the annular space between well screen and surrounding formation.

The sand filter pack shall extend a minimum of 2 feet above the top of the well screen to allow for settling and to isolate the screened interval from the bentonite seal and/or grouting material placed above the screened interval. Occasionally heaving sand from pressure release when the expendable tip is released can "lock" the well material into the rods. When this occurs it can result in the well material being pulled up with the rods. If this condition cannot be corrected by holding the well materials in place as the rods are vibrated and pulled up, it will be necessary extract the well materials and properly abandon the borehole, as described elsewhere. Minor upward displacement of the well is acceptable, as long as the screened interval remains in the desired location.

Bentonite Seal

A bentonite seal is placed above the sand filter pack to prevent cross-contamination or infiltration from above the well screen interval. For wells screened in the Deep Zone of Shallow Aquifer, the bentonite seal will extend from the sand pack up through the entire thickness of the intermediate clay and through the Shallow Zone of the Upper Aquifer to the ground surface. The bentonite seal placed below the water table consists of coated bentonite pellets that will sink through the water column and hydrate after a period of time. Coated pellets are used to prevent the condition of bridging of bentonite that can cause an incomplete seal. The driller will add bentonite pellets slowly and allow them to sink to the base of the rods above the sand pack and/or above previously placed bentonite pellets. Above the water table, granular bentonite hydrated in lifts may be used. During bentonite placement, the driller must verify the top of the pellets with a clean, weighted tape to verify that bridging is not occurring. The rods are vibrated and withdrawn while the pellets are added in lifts. The quantity of pellets added is recorded and compared to the expected annular space volume. Coated pellets are added throughout the saturated portion of the aquifer, through the Intermediate Clay and through the saturated portion of the Shallow Zone of the Upper Aquifer.

If bridging occurs, the following techniques maybe employed to remove the bridge:

- Vibrating drill rods; and/or,
- Using smaller diameter drill rods or PVC pipe to push out the bridge.

Grouting the Annular Space

The remainder of the annular space from the top of the water table to the ground surface will be filled with granular bentonite, cement grout, or bentonite slurry. If grout or slurry are used, they should not be added until sufficient time has passed for the underlying bentonite seal to hydrate, in order to prevent the migration of fine cement/clay particles into the filter pack or monitoring well. Manufacturers may recommend a suitable duration for hydration on material packaging.

Well Completion

The location of the monitoring well will guide well completion. All wells will be capped with an expandable, lockable well cap (i.e., J-plug). Typically a protective steel riser will be set within a concrete pad around the PVC well. Alternatively, the well riser may be cut to an elevation just below ground surface. In this case, a flush mount metal well cover will be set within a concrete pad to protect the well.

Documentation of Field Activities

Detailed documentation of installation activities is essential. At a minimum, the following should be recorded in the field logbook:

1. Start time of well construction;
2. Weather conditions;
3. Intended well construction;
4. Total depth of borehole (assumed to be total depth of well, however, the well may rise when pulling augers);
5. Diameter of borehole and drill tooling;
6. Diameter of the PVC well materials;
7. Depth interval of the well screen;
8. Depth interval of natural collapse;
9. Depth interval of sand filter pack;
10. Depth interval of bentonite seal;
11. Type, size, and quantity of bentonite seal (e.g., chips, pellets, brand name);
12. Depth interval(s) of annular cement grout, bentonite slurry, or bentonite material;
13. Type and quantity of bentonite seal (e.g., chips, pellets, brand name).
14. Surface completion of well;
15. Problems encountered and their resolution during well installation.

Field personnel are responsible for obtaining this information from the drillers. Volumes of sand, bentonite, and/or cement used can be measured by the number of bags required. Bags/packaging will describe the approximate volume of material contained in each bag. Calculating volumes of annular space versus quantity of materials emplaced can be a useful field check to identify inconsistencies (i.e., if there is bridging of bentonite and subsequent creation of voids in the annular space, the volume of material used will be less than the calculated volume of annular space for a given depth interval).

While the documentation of an investigative team's field activities often provides the basis for technical site evaluations and other related written reports, in some cases, all records and notes generated in the field have been considered controlled evidentiary documents and may be subject to scrutiny in litigation. It is essential that field personnel pay attention to detail and document to the extent practical every aspect of the investigation. Field documentation must be legible and provide sufficient information and data to enable reconstruction of field activities.

Following completion of monitoring well installation, boring logs and well construction logs, based on field notes, should be prepared. Blank boring and well construction logs are included for reference.

References

This procedure is guided by the following section from the U.S. EPA Region 4 Science and Ecosystem Support Division – Design and Installation of Monitoring Wells, January, 2013:
Section 2 - Permanent Monitoring Well Design Considerations

SOP #37:
Injection Well Installation
Grenada Manufacturing Site, Grenada, MS

Introduction

This guide is to provide general reference information for the practice and documentation of injection well installation in Grenada, MS.

Definitions

Borehole. An elongate, vertical void in the earth created by drilling (boring) into the formation.

Formation. The natural or fill material that surrounds a boring or well.

Over-drilling. A method of drilling into an existing borehole with augers or drill tooling of larger diameter.

Well Screen. A length of one or more segments of perforated pipe threaded together. The pipe perforations (slots) are large enough to permit free flow of injectant into the desired formation and small enough to prevent the entrance of formation solids. Injection well screens are typically either wire wrapped or factory mill-slotted.

Screened Interval. The depth interval (measured positively and accumulatively from surface to depth) of the formation that is adjacent to the well screen.

Well Riser. A length of one or more segments of solid pipe threaded together extending from the well screen to the surface. The riser threads into the screen through flush threaded connection.

Injection Well. A subsurface construction consisting of a bottom cap affixed to a well screen and riser installed within a borehole that is stabilized and sealed with a filter pack around the well screen and well seal that prevents surface infiltration and/or communication from ground water zones above the filter pack. The well riser is capped with a removable well cap, typically an expanding J-plug type. A lockable protective riser, flushmount or protective steel pipe maybe installed to protect and secure the well.

Silty Clay Surficial Soil. Unconsolidated material dominated by clay and silt-size grains present at ground surface to approximately 15 feet below ground.

Shallow Zone – Upper Aquifer. A zone of saturated fine- to coarse-grained sand with some silt and clay components extending from approximately 15 to approximately 25 feet below ground.

Intermediate Clay. A zone of silty clay the separates the Shallow and Deep Zones of the Upper Aquifer. The Intermediate Clay is thinner and/or absent to the north and west. Its depth, where

present, ranges between approximately 25 to 40 feet below ground. This unit serves as the terminus for wells screened in the Shallow Zone of the Upper Aquifer.

Deep Zone – Upper Aquifer. A zone of saturated fine- to coarse-grained sand with some silt and clay components between the overlying Intermediate Clay and the Shaley Clay Aquitard. The Deep Zone of the Upper Aquifer typically is encountered from approximately 40 to approximately 60 feet below ground.

Shaley Clay Aquitard. A lithologic unit of clay and shale that divides the Upper Aquifer from the Lower Aquifer. The unit is of very low vertical permeability and is considered an aquitard and/or a barrier to groundwater and other substances.

Permeable Reactive Barrier Wall (PRB). A permeable wall of zero valent iron installed east of Riverdale Creek as part of the corrective measures. The PRB extends across the saturated Upper aquifer and is keyed into the shaley-clay aquitard. Impacted water upgradient of the PRB flows through the PRB where it is reduced through residence time with the zero valent iron.

Field Logbook. A bound document with numbered pages used to maintain a chronological record of field activities and data in accordance with field and quality procedures.

Guidelines

Injection wells are installed within boreholes to obtain points for the delivery of injectant into the desired formation. Proper installation of injection wells is critical to achieve the following goals:

1. Allow for the direct transfer of injectant into the desired formation.
2. Enable effective hydraulic connection between injection well and the surrounding formation screened by the well.
3. Limit accumulation of formation solids in the well.

Temporary injection wells or points maybe installed to provide supplemental injection points/locations in addition to the injection well network. Such temporary injection points are typically installed by direct push or rotasonic drilling technologies. Once the injectant is delivered, the temporary injection point is removed from the formation. Grouting or sealing of temporary injection pints may occur in the overlying formations that did not receive the injectant.

Soil sampling for Lithology and Stratigraphy

In areas of good stratigraphic control, logging may not be performed, depending upon project work plans and investigation goals.

A boring is advanced at the intended injection well location with direct push technology (DPT), rotasonic, or hollow-stem auger drilling methods. DPT drilling may utilize a Dual-Tube or Macrocore™ approach to the sampling of soils. These soil cores are retrieved from the boring in acetate sleeves, which are cut open to allow logging of the stratigraphy in accordance with the logging of a DPT boring SOP. When the boring has been logged to at least the depth of the

bottom of the injection screen interval, the DPT tooling is changed to allow advancement of larger diameter rods into the boring created by the tools used for stratigraphic logging.

Well Installation

DPT rods or similar drill tooling with an internal diameter of at least 3-inches are advanced to the intended well screen total depth with an expendable stainless steel tip. Typically, the drilling of 3-inch inside diameter DPT rods is performed in the same borehole created for the sampling of soils for lithology and stratigraphy. The total depth of rod installation will depend upon the injection well design and the desired screen interval, accounting for well bottom cap and expendable stainless steel tip.

Placement of Well Materials

All well materials to be installed per this procedure are to be new, in their original factory packaging and visually inspected as to suitability for use.

The well screen and riser sections are flush-threaded together while lowering the well material into the large-diameter DPT rods.

The well screen will consist of two-inch diameter, schedule 40 PVC with 0.020-inch machined slots, per ASTM standard F480-14. A bottom cap will be attached to the bottom of the well screen. If the screen placement is such that the desired screen length is not an even screen joint length, the base section of screen is cut to the appropriate length and a slip cap is placed on the base of the lowest screen section. The slip cap is not glued to the PVC pipe, but remains in place due to friction. If the screen length is an even interval of 5-feet, the base of the well includes a threaded cap that threads into the internal threads of the screened riser.

Two-inch diameter, internally-threaded, schedule 40 PVC riser is threaded onto the top of the highest length of screen material. Additional riser is threaded to the well string as it is lowered in the DPT rods until the riser extends to or above the ground surface. A well cap is installed to top of the well string to prevent annular materials from entering the temporary groundwater monitoring well.

When the well materials are fully constructed within the DPT rods, the rods are pulled upward with the DPT rig while the well material is held in place. This process results in detachment of the expendable tip at the base of the rod. The rods are vibrated during withdrawal, to the height of the water table, to aid natural collapse of the formation against the well screen. If natural-collapse no longer fills the annular space around the well screen, washed silica sand, appropriately sized for the screen slot size, is installed through the DPT rods to filling the annular space between well screen and surrounding formation.

Occasionally heaving sand from pressure release when the expendable tip is released can “lock” the well material into the rods. When this occurs it can result in the well material being pulled up with the rods. If this condition cannot be corrected by holding the well materials in place as the rods are vibrated and pulled up, it will be necessary extract the well materials and properly

abandon the borehole, as described elsewhere. Minor upward displacement of the well is acceptable, as long as the screened interval remains in the desired location.

Bentonite Seal

A bentonite seal is placed above the water table through the emplacement of granular bentonite hydrated in lifts. During bentonite placement, the driller must verify the top of the bentonitewith a clean, weighted tape to verify that bridging is not occurring. The rods are vibrated and withdrawn while the bentonite lifts are installed. The quantity of bentonite added is recorded and compared to the expected annular space volume.

If bridging occurs, the following techniques maybe employed to remove the bridge:

- Vibrating drill rods; and/or,
- Using smaller diameter drill rods or PVC pipe to push out the bridge.

Grouting the Annular Space

The remainder of the annular space from the top of the water table to the ground surface will be filled with granular bentonite, cement grout, or bentonite slurry. If grout or slurry are used, they should not be added until sufficient time has passed for the underlying bentonite seal to hydrate, in order to prevent the migration of fine cement/clay particles into the filter pack or monitoring well. Manufacturers may recommend a suitable duration for hydration on material packaging.

Well Completion

The location of the monitoring well will guide well completion. All wells will be capped with an expandable, lockable well cap (i.e., J-plug). Typically a protective steel riser will be set within a concrete pad around the PVC well. Alternatively, the well riser may be cut to an elevation just below ground surface. In this case, a flush mount metal well cover will be set within a concrete pad to protect the well.

Documentation of Field Activities

Detailed documentation of installation activities is essential. At a minimum, the following should be recorded in the field logbook:

1. Start time of well construction;
2. Weather conditions;
3. Intended well construction;
4. Total depth of borehole (assumed to be total depth of well, however, the well may rise when pulling augers);
5. Diameter of borehole and drill tooling;
6. Diameter of the PVC well materials;
7. Depth interval of the well screen;
8. Depth interval of natural collapse;

9. Depth interval of sand filter pack;
10. Depth interval of bentonite seal;
11. Type, size, and quantity of bentonite seal (e.g., chips, pellets, brand name);
12. Depth interval(s) of annular cement grout, bentonite slurry, or bentonite material;
13. Type and quantity of bentonite seal (e.g., chips, pellets, brand name).
14. Surface completion of well;
15. Problems encountered and their resolution during well installation.

Field personnel are responsible for obtaining this information from the drillers. Volumes of sand, bentonite, and/or cement used can be measured by the number of bags required. Bags/packaging will describe the approximate volume of material contained in each bag. Calculating volumes of annular space versus quantity of materials emplaced can be a useful field check to identify inconsistencies (i.e., if there is bridging of bentonite and subsequent creation of voids in the annular space, the volume of material used will be less than the calculated volume of annular space for a given depth interval).

While the documentation of an investigative team's field activities often provides the basis for technical site evaluations and other related written reports, in some cases, all records and notes generated in the field have been considered controlled evidentiary documents and may be subject to scrutiny in litigation. It is essential that field personnel pay attention to detail and document to the extent practical every aspect of the investigation. Field documentation must be legible and provide sufficient information and data to enable reconstruction of field activities.

Following completion of monitoring well installation, boring logs and well construction logs, based on field notes, should be prepared. Blank boring and well construction logs are included for reference.

References

This procedure is guided by the following section from the U.S. EPA Region 4 Science and Ecosystem Support Division – Design and Installation of Monitoring Wells, January, 2013:
Section 2 - Permanent Monitoring Well Design Considerations

SOP #39:
Field Description, Logging and Identification of Soil and/or Rock
Grenada Manufacturing Site, Grenada, MS

Introduction

This guide is to provide general reference information for the logging, description and identification of soils and/or rock material(s) by visual manual methods. Only qualified field personnel shall log geologic materials.

Definitions

And. Having roughly equal amounts of two or more descriptors. Example: Fine and medium sand.

Angular. Particles having sharp edges and planar surfaces with unpolished surfaces.

Blocky. Cohesive soil that can be broken into small angular lumps which resist further breakdown.

Borehole. An elongate, vertical void in the earth created by drilling (boring).

Boring Log. A record of the soils and rock lithology and stratigraphy encountered in a boring.

Chaotic. No discernable pattern.

Core. A cylindrical section of rock, usually 1to 6 inches (2.5 to 10 centimeters) in diameter and up to several feet in length, obtained by a core bit and barrel tool and brought to the surface for examination and/or sampling.

Core barrel. A hollow cylinder attached to a specially designed bit and used in an attempt to obtain and preserve a relatively continuous section or core of the rocks penetrated in drilling.

Decomposed. Rock that resembles soil with partial or complete rock structure preserved. Discolored or oxidized throughout; but, resistant minerals such as quartz may be unaltered; complete clay alteration of iron and magnesium minerals; disaggregated; can be granulated by hand.

Dilatancy. The property of becoming more viscous under pressure or shear strain. *Slow dilantancy* is when water appears slowly on the surface of a specimen during shaking and does not disappear upon squeezing. *Rapid dilatancy* is the quick appearance of water upon

shaking and the quick disappearance of water upon squeezing.

Dry. No discernable moisture.

Elongated. Particles with length/width >3.

Few. Between 5 and 10%.

Field Logbook. A bound document with numbered pages used to maintain a chronological record of field activities, to identify the personnel involved, and to record data and information obtained during field activities. Boring log field sheets can also be used.

Fissured. Breaks along definite planes of fracture with little resistance to fracturing.

Flat. Particles with width/thickness > 3.

Flat and Elongated. Particles meet criteria for both flat and elongated.

Fresh. Rock surface with no discoloration or oxidation.

From/to. Having properties of three or more descriptors, including all descriptors within the range. Example: From rounded to angular.

Grading from/to. or Increasing/Decreasing from/to. Denoting a gradual change over distance or depth. Example: Grading from moderately weathered to fresh.

High plasticity. It takes considerable time rolling and kneading to reach the plastic limit. The thread can be rerolled several times before reaching the plastic limit. The lump can be formed without crumbling when drier than the plastic limit.

High strength. The dry specimen cannot be broken with finger pressure. Specimen will break between thumb and hard surface.

Homogenous. Same color an appearance throughout.

Intensely Weathered. Discoloration or oxidation throughout; may include clay alteration; chemical alteration produces in situ disaggregation; discolored surfaces maybe friable; dull sound when struck by hammer; usually broken by moderate to heavy manual pressure or by light hammer blow without reference to planes of weakness.

Laminated. Alternating layers of varying material or color with the layers less than ¼-inch thick.

Lensed. Inclusion of small pockets of different soil within a larger mass of soil; note thickness.

Little. Between 15 and 25%.

Locally. Occuring at random locations.

Low plasticity. A thread can barely be rolled and the lump cannot be formed when drier than the plastic limit.

Low strength. The dry specimen crumbles into powder with some finger pressure.

Massive. Greater than 10 feet in sedimentary or volcanic rock bedding thickness.

Medium plasticity. A thread is easy to roll and not much time is required to reach the plastic limit; and, the lump crumbles when drier than the plastic limit.

Moderate cementation. Coarse soil that crumbles or breaks with considerable finger pressure.

Moderately Bedded. Sedimentary or volcanic rock beds between 4-inches and 1 foot thick.

Moderately Weathered. All fractures and surfaces are discolored or oxidized and discoloration extends from fractures; iron and magnesium minerals are "rusty" feldspar maybe "cloudy;" partial separation of boundaries; does not ring when struck by hammer.

Moist. Moisture present, but no free water.

Mostly. Greater than 50%.

Mottled. Having spots or blotches of different color; more than variegated but less than multicolored.

Multicolored. Lots of colors (state predominant colors).

None. Absence. When referring to strength, specimen crumbles to powder with mere pressure of handling.

Nonplastic. A 1/8-inch thread cannot be rolled at any water content.

Predominantly. Having more than any other constituent.

Rock, bedrock. A combination of one or more minerals, e.g., granite, shale, marble; or a body of undifferentiated mineral(s), e.g., obsidian.

Rhythmically. Occurring at regular, predictable locations.

Rounded. Particles have smoothly curved sides with no edges.

Scattered. Occurring at widely spaced and usually irregular intervals.

Slickensided. Fracture planes are polished or glossy, sometimes striated.

Slightly Weathered. A tight/intact rock where discoloration or oxidation is limited to surface or a short distance from surface/fractures.

Some. Between 30 and 45%.

Sporadic. Occurring singly or widely apart.

Stratified. Alternating layers of varying material or color with layers at least ¼-inch thick; note thickness.

Strong cementation. Coarse soil that will not crumble or break with finger pressure.

Subangular. Particles are similar to angular but with rounded edges.

Subsurface soil. The regolith occurring between surface soil and bedrock.

Subrounded. Particles have nearly planar sides but rounded edges and corners.

Surface soil. Generally considered to be the top 6 inches of a soil horizon profile (i.e., soil from O to 6- inches below ground surface [bgs]). Depending on the program or project, however, soil to 2 feet bgs may be considered surface soil.

Thickly Bedded. Sedimentary or volcanic rock bedding between 1 and 3 feet thick.

Thinly Bedded. Sedimentary or volcanic rock beds between 1 and 4-inches thick.

To. Intermediate, having properties in between two adjacent descriptors. Example: Moderately hard to moderately soft.

Trace. Less than 5%.

Varies from/to. or "-" [used with numeric ranges]. Denotes non-uniform variation, does not include all descriptors within range. Example: Varies from soft to hard; or, 4-6"

Cobbles.

Variegated. Having streaks, marks or patches of different color; varicolored. Example: Variegated green, grey, and black.

Very High strength. The dry specimen cannot be broken between thumb and hard surface.

Very Thickly Bedded. Sedimentary or volcanic rock bedding between 3 and 10 feet thick.

Very Thinly Bedded. Sedimentary or volcanic rock bedding between ¼ and 1-inch thick.

Void. A gap, hole, or absence of material.

Weak cementation. Coarse soil that crumble or breaks with handling or light finger pressure.

Wet. Visible free water.

Field Equipment

The equipment and supplies required for T&M Associate's personnel include the following:

- Project-specific Health and Safety Plan (HASP), Work Plan, Quality Assurance Project Plan (QAPP), and Field Sampling Plan (FSP).
- Applicable Standard Operating Procedures.
- Measuring tape and water level tape.
- Field Notebook.
- Field data forms.
- Camera.
- Sample containers, cooler and ice.
- Air monitoring equipment as required by HASP; if headspace samples or screening of VOCs is required, PID or FID.
- Hand lens.
- Nitrile or latex exam gloves; leather work gloves.
- Stainless steel spoons/trowels and/or stainless steel hand augers, if applicable.
- Resealable plastic bags: for headspace tests and moisture samples typically quart size or smaller; for sample collection and/or ice typically gallon size or larger.
- 5-gallon buckets and/or sample collection bags (e.g., feed bags, cloth sample and/or resalable plastic bags), if applicable.

- Resealable plastic bags: for headspace tests and moisture samples typically quart size or smaller; for sample collection and/or ice typically gallon size or larger, if applicable.
- 5-gallon buckets, if applicable.
- Clear tape, strapping tape, duct tape.
- Ball point and indelible ink (Sharpie) pens.
- Paper towels or Kimwipes.
- Core boxes, if rock coring;
- Wood (e.g., 1-inch X 2-inch) and saw, if rock coring;
- Geologist's hammer;
- Rock chisel, if rock present;
- Mesh strainer, if rotary drilling;
- Shovel;
- Knife;
- Potable water or deionized water;
- Dilute (10%) hydrochloric acid or muriatic acid.

Guidelines

This SOP may be used for the description of soil and rock as encountered in borings, core borings, stockpiles, test pits, excavations, or outcrops. It provides guidance for soil logging, rock logging, taking headspace readings, and additional considerations when logging from excavations and outcrops.

Sample Locations Details

The following information should be recorded for each boring or sampling location:

- Dates of work.
- Project and site information.
- Location ID and location description.
- Survey information (if available).
- Personnel conducting logging.
- Drilling or Excavator personnel.
- Drill rig/Excavator manufacturer and model.
- Drilling/Excavator method.
- Drill rod description (diameter).
- Drill bit description/Excavator bucket size.
- Circulation method
- Casing: type, diameter and installation depth(s), cement or sealant.
- SPT hammer description and lifting mechanism.
- Type(s) of sampler(s) and size(s), depth intervals.
- Decontamination methods.

- Source of drilling water or circulation.
- Documentation of circulation air is visually clean and oil free when sprayed against a clean white cloth or paper towel.
- Groundwater: method (observed while drilling, observed in augers, measured in augers, measured in open hole, measure in temporary well, etc.) and date, time, and elevation or depth from common measuring datum; note measuring datum.
- Weather conditions.

Additional Notations for Drilling Methodologies

The following protocols and notations shall be followed/recorded while drilling via each of the drilling methods below:

Standard Penetration Test (SPT)
If soils are sampled via split spoons, record the number of standard penetration hammer blows per each 6-inch interval of the sampler. If split spoon refusal or a maximum of 50 hammer blows is performed record "R" or "50"/the number of inches penetrated within that 6-inch interval. E.g., "5-8-32-50/3" translates to a split spoon sampler being hammered by 5 blows to advance the first 6-inches; 8 hammer blows to advance form 6-inches to 1 foot; 32 hammer blows to advance to 18-inches; and refusal through only advancing 3-inches (total advancement of 19-inches) with an additional 50 hammer blows.

Rotary Drilling and/or Rock Coring
- The diameter and type of drill bit.
- The inside and outside diameter of both the core barrel and casing.
- The start and stop drilling times for advancing each drilling rod or joint shall be recorded.
- The depth and time of circulation loss and/or gain.
- The amount of circulation used for each drilling interval (typically determined by recording the water meter readings at the start and end of each drilled interval or core run).

Rotasonic Drilling
- The inside and outside diameter of both the core barrel and casing.
- The start and stop drilling times for advancing each drilling rod or joint shall be recorded.
- The depth and time of circulation loss and/or gain.
- The amount of circulation used for each drilling interval (typically determined by recording the water meter readings at the start and end of each drilled interval or core run).

Soil Logging
The logging or systematic description of soils shall be recorded by a qualified person on a boring log form, in bound field logbook, or directly into electronic format (Excel file, EQUIS form or widget, or other geologic software).

Soils shall be logged in accordance with the *Standard Practice for Description and Identification of Soils (Visual and Manual Procedure)* (ASTM D-2488). The following information should be recorded for each identified soil unit:

- Soil Identification; capitalize:
    - If a major component comprises >50% of the soil, then the major component descriptor should be fully capitalized (SILT);
    - If the major component comprises <50% of the sample, then only the first letter of the major component descriptor should be capitalized (Silt).
- Consistency of cohesive soil.
- Apparent density of loose soil.
- Color.
- Particle size, angularity and shape (note for cobbles and boulders note if intersected length, which may not represent maximum size due to drilling orientation).
- Plasticity (for fine grained soils).
- Dry Strength.
- Dilatency.
- Structure.
- Cementation.
- Moisture.
- Indications of contamination (describe nature, color, density, odor, etc.).
- Additional comments (e.g., mineralization, fossils, geologic formation name or soil survey unit, etc.).
- Additional drilling/excavation observations (caving, sloughing, difficulty in drilling/trenching, loss/gain of drilling fluid/circulation, changes in drilling/excavation methods or tooling, intervals of samples, etc.).
- Air monitoring and headspace results.

Rock Classification

The logging or systematic description of rock shall be recorded by a qualified person on a boring log form, in bound field logbook, or directly into electronic format (Excel file, EQUIS form or widget, or other geologic software).

At a minimum, the following information should be recorded as part of the rock log:

- Rock Type.
- Rock Name.
- Grain or Crystal Size.
- Bedding spacing and description.
- Color.
- Weathering.
- Rock hardness.
- Fracture(s): depth interval, density, frequency, spacing, size, continuity, orientation, weathering or alteration, hardness, healing, roughness, natural or mechanical.
- The Rock Quality Designation (RQD) should be recorded as an approximation of the rock's structural integrity and is the total length of all core pieces longer than 4 inches as a result of natural breaks (r) divided by the total length of the rock core (l), converted to a percentage.
- Slaking.
- Relative Strength.
- Depth to water and any water-bearing zones

- Additional comments (e.g., mineralization, fossils, geologic formation name, etc.).
- Additional drilling/excavation observations (caving, sloughing, difficulty in drilling/trenching, loss/gain of drilling fluid/circulation, changes in drilling/excavation methods or tooling).
- Air monitoring and headspace results.

Headspace Screening

Aliquots of soil and rock can be screened for volatile organic compounds by the following technique.

- Once the core or sampler is open fill sample jars/containers per the sampling plan.
- Immediately after analytical sample containers are filled, place representative aliquot(s) of soil or rock fragments in a new, resalable plastic bag for each headspace interval. Ensure the bag is sealed once the headspace sample is collected. Generally, headspace samples are taken at predetermined depths or at common intervals so as to provide a record of field screening with depth. Typically headspace aliquots are taken at 1 to 2 feet intervals and, typically, include at least one sample from each hydrogeologic unit.
- Each bag should be labelled with: Location ID, depth, and sample time. If headspace samples are to be archived include date, as well.
- Headspace samples should be allowed to volatilize into the atmosphere within the sealed plastic bag. Kneading the sample and or breaking up clumps (with the bag still sealed) to maximize surface area of the material within the bag will help to promote volatilization. If the ambient temperature is below 70F, headspace bags should be allowed to warm in a heated vehicle or field office for a at least 15 minutes prior to screening.
- Screening is performed through use of a calibrated direct reading photo-ionization detector or equivalent. A corner of the sealed plastic bag is opened just enough to allow for the detector's probe to enter the bag. The bag is quickly resealed around the probe. The atmosphere within the bag is measured and the highest value recorded.

Additional Considerations for Excavations

Excavations shall follow OSHA's 40CFR 1926 Subpart P Excavation standards and other applicable Standards (40 CFR 1910.120, etc.). No one shall be allowed to enter an unsupported or open excavation unless a competent person inspects the excavation first.

If at all possible, non-entry sampling of excavations shall be performed. This can be achieved by sampling from excavator buckets.

Sketch maps and photographs can be taken to document the excavation side walls and bottom. The General Considerations for Outcrops, below, should be applied to each excavation.

Additional Considerations for Outcrops

Photographs and sketch map(s) of each outcrop should be taken/made with details relating to the features observed, both up close and at distance, sample locations, relationship of units and primary and secondary structures, seepages, locations of photographs, etc.

- Look over the outcrop from a distance in order to broadly spot principle bodies of rock or other materials.
- Look over the outcrop from a medium distance in order to determine the orientation and shapes of individual rock bodies, changes in color, changes in moisture or evidence of seepage (if

identified note source unit, flow rate and direction), etc.

- Look over the individual contact surfaces boundaries. Describe their nature (sharp, gradational, unconformity); relationship with other bodies (cross-cutting, internal, etc.).
- Note lithology and descriptions of each rock unit following the rock logging checklist above.
- Note depositional and/or structural features (e.g., faults, joints, scours, ripples, foliations, cleavage, etc.). Note distributions/variations in spacing and frequency, grain size, weathering, color, mineralization/alteration with these structures.
- Measure the thickness of each layered rock unit; location thickness and orientation of primary and secondary structures.
- Measure strike and dip of beds, layers, planar fabrics, cleavages, faults, joints, veins and dikes.
- Note the types and locations of fossils.
- Note the locations of samples.

References

ASTM D-

Compton, Robert R. (1985). *Geology in the Field*. John Wiley & Sons: New York.

Chapter 6 of the *New Jersey Department of Environmental Protection Field Sampling Procedures Manual*. http://www.nj.gov/dep/srp/guidance/fspm/pdf/chapter06b.pdf

Technical Guidance Manual (TGM) for Hydrogeologic Investigations and Ground Water Monitoring. http://epa.ohio.gov/ddagw/gw_support.aspx#126913976-technical-guidance-manual-tgm

Appendix C

Quality Assurance Manual

TestAmerica Canton

4101 Shuffel Street NW

North Canton, OH 44720

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Fax: 330-497-0772

www.testamericainc.com

Facility Distribution No. _____ **Distributed To:_____**

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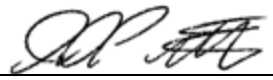
1. TITLE PAGE:

Quality Assurance Manual

Approval Signatures



07/15/14

Laboratory Director – Daniel Pittman — Date

07/15/14

Quality Assurance Manager – Dee Shepperd — Date

07/16/14

Technical Director – Raymond Risden — Date

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SOP/Policy Reference	Title
CA-C-S-001	Work Sharing Process
CW-Q-S-003	Internal Auditing
CW-L-P-004	Ethics Policy
CA-L-P-002	Contract Compliance Policy
CW-L-S-002	Internal Investigation of Potential Data Discrepancies and Determination for Data Recall
CA-L-S-002	Subcontracting Procedures
CA-Q-S-001	Solvent and Acid Lot Testing and Approval
CA-Q-S-002	Acceptable Manual Integration Practices
CA-Q-S-004	Method Compliance & Data Authenticity Audits
CA-Q-S-006	Detection Limits
CA-Q-S-008	Management Systems Review
CA-T-P-001	Qualified Products List
CW-E-M-001	Corporate Environmental Health & Safety Manual
CW-F-P-002	Company-wide Authorization Matrix
CW-F-P-004	Procurement and Contracts Policy
CW-F-S-007	Capital Expenditure, Controlled Purchase Requests, and Fixed Asset Capitalization
CW-Q-S-001	Corporate Document Control and Archiving
CW-Q-S-002	Writing a Standard Operating Procedure (SOP)
CA-Q-M-002	Corporate Quality Management Plan
NC-QA-015	Equipment Monitoring and Thermometer Calibration
NC-QA-018	Statistical Evaluation of Data and Development of Control Charts
NC-QA-019	Records Information Management
NC-QA-027	Preparation and Management of Standard Operating Procedures (SOPs)
NC-QA-028	Employee Orientation and Training
NC-QA-029	Nonconformance and Corrective Action System
NC-QA-030	Document Control
NC-SC-005	Sample Receiving and Sample Control
NC-SC-006	Sample Procurement Protocol
CA-Q-T-005	Laboratory Documentation
NC-QA-021	Evaluation of Method Detection Limits for Chemical Tests
NC-QA-031	Internal Audits

3. INTRODUCTION, SCOPE, AND APPLICABILITY

3.1. Introduction and Compliance References

3.2. TestAmerica Canton's Quality Assurance Manual (QAM) is a document prepared to define the overall policies, organizational objectives and functional responsibilities for achieving TestAmerica's data quality goals. The laboratory maintains a local perspective in its scope of services and client relations and maintains a national perspective in terms of quality.

3.3. The QA Manual has been prepared to assure compliance with the NELAC Institute (TNI) Standard, dated 2009, Volume 1, Modules 2 and 4, ISO/IEC Guide 17025:2005(E), and DoD QSM 4.2 (will transition to QSM 5.0 in 2015). In addition, the policies and procedures outlined in this manual are compliant with TestAmerica's Corporate Quality Management Plan, CA-Q-M-002, (CQMP) and the various accreditation and certification programs listed in Appendix 4. The CQMP provides a summary of TestAmerica's quality and data integrity system. It contains requirements and general guidelines under which all TestAmerica facilities shall conduct their operations. The relevant NELAC section is included in the heading of each QAM section.

3.4. The QA Manual has been prepared to be consistent with the requirements of the following documents:

3.4.1. EPA 600/4-79-019, Handbook for Analytical Quality Control in Water and Wastewater Laboratories, EPA, March 1979.

3.4.2. Test Methods for Evaluating Solid Waste Physical/Chemical Methods (SW846), Third Edition, September 1986, Final Update I, July 1992, Final Update IIA, August 1993, Final Update II, September 1994; Final Update IIB, January 1995; Final Update III, December 1996; Final Update IV, January 2008.

3.4.3. U.S. Department of Defense, (DoD)/Department of Energy (DOE) Consolidated Quality Systems Manual (QSM) for Environmental Laboratories, Version 4.2, October 2010 (transitioning in 2015 to QSM 5.0, July 2013).

3.4.4. APHA, Standard Methods for the Examination of Water and Wastewater, 18th Edition, 19th, 20th, 21st, and on-line Editions.

3.4.5. Statement of Work for Inorganics & Organics Analysis, SOM and ISM, current versions, USEPA Contract Laboratory Program Multi-media, Multi-concentration.

3.4.6. Federal Register, 40 CFR Parts 136, 141, 172, 173, 178, 179 and 261.

3.4.7. Toxic Substances Control Act (TSCA).

3.5. Terms and Definitions

3.5.1. A Quality Assurance Program is a company-wide system designed to ensure data produced by the laboratory conforms to the standards set by state and/or federal regulations. The program functions at the management level through company goals and management policies, and at the analytical level through Standard Operating Procedures (SOPs) and quality control. The TestAmerica program is designed to minimize systematic error, encourage constructive, documented problem solving, and provide a framework for continuous improvement within the organization.

3.5.2. Refer to Appendix 3 for the Glossary/Acronyms.

3.6. Scope / Fields of Testing

3.6.1. The laboratory analyzes a broad range of environmental and industrial samples every month. Sample matrices vary among effluent water, groundwater, hazardous waste, sludge, wipes, and soils. The Quality Assurance Program contains specific procedures and methods to test samples of differing matrices for chemical, physical and biological parameters. The Program also contains guidelines on maintaining documentation of analytical processes, reviewing results, servicing clients and tracking samples through the laboratory. The technical and service requirements of all analytical requests are thoroughly evaluated before commitments are made to accept the work. Measurements are made using published reference methods or methods developed and validated by the laboratory.

3.6.2. The methods covered by this manual include the most frequently requested methodologies needed to provide analytical services in the United States and its territories. The specific list of test methods used by the laboratory can be found in Appendix 2 . The approach of this manual is to define the minimum level of quality assurance and quality control necessary to meet these requirements. All methods performed by the laboratory shall meet or exceed these criteria, as appropriate. In some instances, quality assurance project plans (QAPPs), project specific data quality objectives (DQOs) or local regulations may require criteria other than those contained in this manual and the referenced methods. In these cases, the laboratory must abide by the requested criteria following review and acceptance of the requirements by the Laboratory Director, the Quality Assurance (QA) Manager, and the Technical Director. In some cases, QAPPs and DQOs may specify less stringent requirements. The Technical Director and the QA Manager must determine if it is in the lab's best interest to follow the less stringent requirements.

3.6.3. Specific requirements delineated in project plans may supersede general quality requirements described in this manual. Ohio VAP requirements are listed throughout the document.

3.7. Management of the Manual

3.7.1. Review Process

3.7.1.1. The template on which this manual is based is reviewed annually by Corporate Quality Management personnel to assure it remains in compliance with Section 3.1. This manual itself is reviewed annually by senior laboratory management to assure that it reflects current practices and meets the requirements of the laboratory's clients and regulators as well as the CQMP. Occasionally, the manual may need changes in order to meet new or changing regulations and operations. The QA Manager must review the changes in the normal course of business and incorporate changes into revised sections of the document. All updates must be reviewed by the senior laboratory management staff (Laboratory Director, Technical Director, Operations Manager, and QA Manager). The laboratory updates and approves such changes according to our Document Control SOP (NC-QA-030) and Updating Procedures SOP (NC-QA-027).

4. MANAGEMENT REQUIREMENTS

4.1. Overview

4.1.1. TestAmerica Canton is a local operating unit of TestAmerica Laboratories, Inc. The organizational structure, responsibilities, and authorities of the corporate staff of TestAmerica Laboratories, Inc. are presented in the CQMP. The laboratory has day-to-day independent operational authority overseen by corporate officers (e.g., Chief Executive Officer (CEO), Executive VP Operations, Corporate Quality, and EH&S Director, etc.). The laboratory operational and support staff work under the direction of the Laboratory Director. The organizational structure for both Corporate and TestAmerica North Canton is presented in Figure 4-1. Employee names are provided to demonstrate range and size of departments however the actual staff members may vary over time. The most current Organization Chart may be obtained from Quality Assurance Manager or Laboratory Director.

4.2. Roles and Responsibilities

4.2.1. In order for the Quality Assurance Program to function properly, all members of the staff must clearly understand and meet their individual responsibilities as they relate to the quality program. The following descriptions briefly define each role in its relationship to the Quality Assurance Program. More extensive job descriptions are maintained by laboratory management.

4.3. Additional Requirements for Laboratories

4.3.1. The responsibility for quality resides with every employee of the laboratory. All employees have access to the QAM, are trained to this manual, and are responsible for knowing the content of this manual and upholding the standards therein. Each person carries out his/her daily tasks in a manner consistent with the goals and in accordance with the procedures in this manual and the laboratory's SOPs. Role descriptions for Corporate personnel are defined in the CQMP. This manual is specific to the operations of TestAmerica's Canton laboratory.

4.4. Canton Laboratory Key Personnel

Name	Position
Rusty Vicinie	VP of Operations, Central
Daniel Pittman	Laboratory Director
Raymond Risden	Technical Director
Carolynne Roach	Operations Manager
Dee Shepperd	Quality Assurance Manager
Rebecca Strait	Client Relations Manager
Steve Jackson	Regional Safety Director, Waste Management Supervisor
Chris Coast	Extractions Group Leader
Will Cordell	Field Analytical Group Leader
Olguita Colon	GC Volatile/Semivolatiles Group Leader
Tom Hula	GC/MS Semivolatiles Group Leader
Lucas Grossman	General Chemistry Group Leader
Darren Miller	Maintenance
Aaron Martin	Metals Group Leader
Patrick O'Meara	Project Management Group Leader
Ann Maddux	Sample Control Group Leader
Lance Hershman	Shipping Group Leader

4.5. Quality Assurance (QA) Manager or Designee

4.5.1. The QA Manager has responsibility and authority to ensure the continuous implementation of the quality system.

4.5.2. The QA Manager reports directly to the Laboratory Director, and has access to Corporate QA for advice and resources. This position is able to evaluate data objectively and perform assessments without outside (e.g., managerial) influence. Corporate QA may be used as a resource in dealing with regulatory requirements, certifications, and other quality assurance related items. The QA Manager directs the activities of the QA officers to accomplish specific responsibilities, which include, but are not limited to:

4.5.2.1. Serves as the focal point for QA/QC in the laboratory.

4.5.2.2. Having functions independent from laboratory operations for which he/she has quality assurance oversight.

4.5.2.3. Maintaining and updating the QA Manual.

4.5.2.4. Monitoring and evaluating laboratory certifications, scheduling proficiency testing (PT) samples.

4.5.2.5. Monitoring and communicating to management, regulatory changes that may affect the laboratory.

4.5.2.6. Training and advising the laboratory staff on quality assurance/quality control (QA/QC) procedures that are pertinent to their daily activities.

4.5.2.7. Having documented training and/or experience in QA/QC procedures and the laboratory's Quality System.

4.5.2.8. Having a general knowledge of the analytical test methods for which data audit/review is performed (and/or having the means of getting this information when needed).

4.5.2.9. Arranging for or conducting internal audits on quality systems and the technical operation.

4.5.2.10. Maintaining records of all ethics-related training, including the type and proof of attendance.

4.5.2.11. Maintaining, improving, and evaluating the corrective action database and the corrective and preventive action systems.

4.5.2.12. Notifying laboratory management of deficiencies in the quality system and ensuring corrective action is taken. Procedures that do not meet the standards set forth in the QA Manual or laboratory SOPs shall be investigated following procedures outlined in Section 12; and if deemed necessary, may be temporarily suspended during the investigation.

4.5.2.13. Objectively monitoring standards of performance in QC and QA without outside (e.g., managerial) influence.

4.5.2.14. Coordinating of document control of SOPs, MDL, control limits, and miscellaneous forms and information.

4.5.2.15. Reviewing a percentage of all final data reports for internal consistency. Review of Chain of Custody (COC), correspondence with the analytical request, batch QC status, completeness of any corrective action statements, 5% of calculations, format, holding time, reasonableness of results and completeness of the project file contents.

4.5.2.16. Reviewing external audit reports and data validation requests.

4.5.2.17. Following up with data and laboratory audits to ensure client QAPP requirements are met.

4.5.2.18. Establishing reporting schedule and preparation of various quality reports for the Laboratory Director, clients and/or Corporate QA.

4.5.2.19. Developing suggestions and recommendations to improve quality systems.

4.5.2.20. Researching current state and federal requirements and guidelines.

4.5.2.21. Captaining the QA team to enable communication and to distribute duties and responsibilities.

4.5.2.22. Ensuring communication and monitoring standards of performance to ensure systems are in place to produce the level of quality as defined in this document.

4.5.2.23. Evaluating the thoroughness and effectiveness of training.

4.5.2.24. Assuring compliance with ISO 17025.

4.5.2.25. Assuring compliance with DoD ELAP.

4.6. Technical Director & Department Group Leader

4.6.1.1. The Technical Director reports directly to the Laboratory Director. The Technical Director along with the Laboratory Director, the QA Manager, the Operations Manager, and each Department Group Leader is accountable for compliance with the ISO 17025 Standard. The Technical Director works with QA and Department Group Leaders to solve day-to-day technical issues, provide technical training and guidance to laboratory staff, project managers, and clients, and assists with method development and validation.

4.6.1.2. The Department Group Leaders report to the Operations Manager. The Group Leaders maintain overall responsibilities for a defined portion of the laboratory. These responsibilities include but are not limited to:

4.6.1.3. Day-to-day supervision of laboratory operations for the appropriate field of accreditation and reporting of results. Working with the QA Manager to coordinate preparation of test method SOPs and perform subsequent analyst training and interpretation of the SOPs for implementation and unusual project samples and/or requirements.

4.6.1.4. Monitoring the validity of the analyses performed and data generated in the laboratory.

4.6.1.5. Providing training and development programs to applicable laboratory staff as new hires and, subsequently, on a continuing, scheduled basis. Training includes instruction on calculations, instrumentation, troubleshooting, and preventive maintenance.

4.6.1.6. Enhancing efficiency and improving quality through technical advances and improved laboratory information management system (LIMS) utilization. Capital forecasting and instrument life cycle planning for second generation methods and instruments as well as asset inventory management.

4.6.1.7. Working with the QA Manager in scheduling all QA/QC-related requirements for compliance, e.g. MDLs, etc.

4.6.1.8. Captains department personnel to communicate quality, technical, personnel and instrumental issues for a consistent team approach.

4.6.1.9. Compliance with ISO 17025 (where applicable).

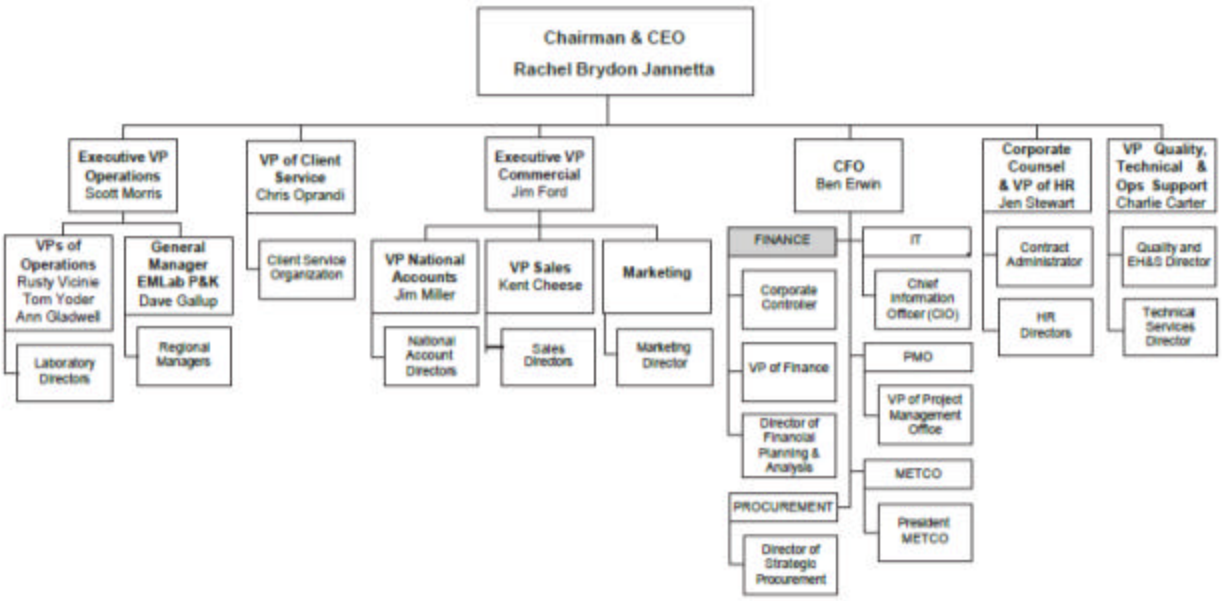
4.6.1.10. Compliance with DoD ELAP (where applicable).

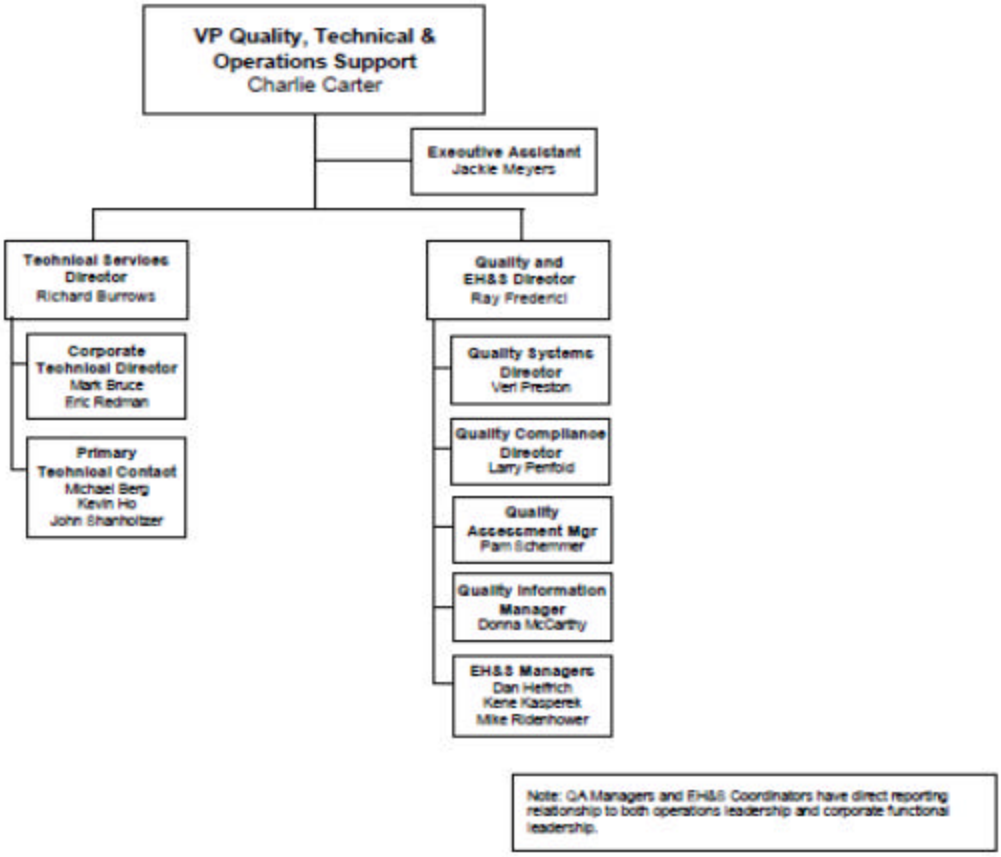
4.6.2. Deputies

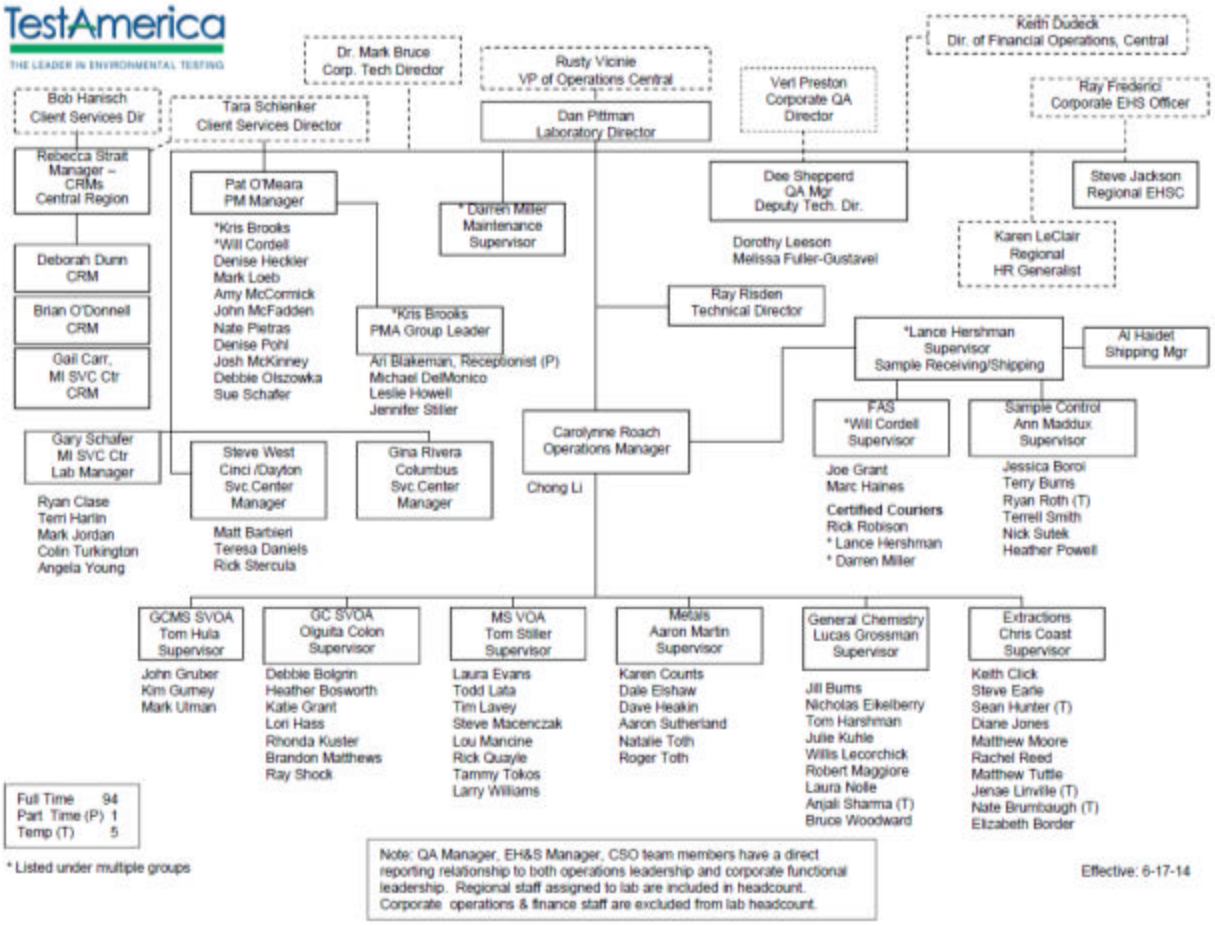
4.6.2.1. The following table defines who assumes the responsibilities of key personnel in their absence:

Key Personnel	Deputy
Laboratory Director	Technical Director QA Manager
Quality Assurance Manager	Laboratory Director Quality Assurance Coordinator
Technical Director	Operations Manager Quality Assurance Manager
EHS Coordinator	Technical Director Operations Manager

Figure 4-1. Corporate and Laboratory Organization Charts




VP Quality, Technical & Operations Support
Charlie Carter
Executive Assistant
Jackie Meyers
Technical Services Director
Richard Burrows
Corporate Technical Director
Mark Bruce
Eric Redman
Primary Technical Contact
Michael Berg
Kevin Ho
John Shanholtzer
Quality and EH&S Director
Ray Frederici
Quality Systems Director
Veri Preston
Quality Compliance Director
Larry Penfold
Quality Assessment Mgr
Pam Schemmer
Quality Information Manager
Donna McCarthy
EH&S Managers
Dan Helfrich
Kene Kasperek
Mike Ridenhower
Note: QA Managers and EH&S Coordinators have direct reporting relationship to both operations leadership and corporate functional leadership.


TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING
Dr. Mark Bruce
Corp. Tech Director
Rusty Vicinie
VP of Operations Central
Keith Dudeck
Dir. of Financial Operations, Central
Bob Hanisch
Client Services Dir
Tara Schlenker
Client Services Director
Dan Pittman
Laboratory Director
Veri Preston
Corporate QA Director
Ray Frederici
Corporate EHS Officer
Rebecca Strait
Manager – CRMs
Central Region
Pat O'Meara
PM Manager
*Kris Brooks
*Will Cordell
Denise Heckler
Mark Loeb
Amy McCormick
John McFadden
Nate Pietras
Denise Pohl
Josh McKinney
Debbie Olszowka
Sue Schafer
* Darren Miller
Maintenance
Supervisor
Dee Shepperd
QA Mgr
Deputy Tech. Dir.
Dorothy Leeson
Melissa Fuller-Gustavel
Steve Jackson
Regional EHSC
Karen LeClair
Regional
HR Generalist
Deborah Dunn
CRM
Brian O'Donnell
CRM
Gail Carr,
MI SVC Ctr
CRM
*Kris Brooks
PMA Group Leader
Ari Blakeman, Receptionist (P)
Michael DelMonico
Leslie Howell
Jennifer Stiller
Ray Risden
Technical Director
*Lance Hershman
Supervisor
Sample Receiving/Shipping
Al Haidet
Shipping Mgr
Gary Schafer
MI SVC Ctr
Lab Manager
Ryan Clase
Terri Hartin
Mark Jordan
Colin Turkington
Angela Young
Steve West
Cinci /Dayton
Svc.Center
Manager
Matt Barbieri
Teresa Daniels
Rick Stercula
Gina Rivera
Columbus
Svc.Center
Manager
Carolynne Roach
Operations Manager
Chong Li
FAS
*Will Cordell
Supervisor
Joe Grant
Marc Haines
Certified Couriers
Rick Robison
* Lance Hershman
* Darren Miller
Sample Control
Ann Maddux
Supervisor
Jessica Boroi
Terry Burns
Ryan Roth (T)
Terrell Smith
Nick Sutek
Heather Powell
GCMS SVOA
Tom Hula
Supervisor
John Gruber
Kim Gurney
Mark Ulman
GC SVOA
Olguita Colon
Supervisor
Debbie Bolgrin
Heather Bosworth
Katie Grant
Lori Hass
Rhonda Kuster
Brandon Matthews
Ray Shock
MS VOA
Tom Stiller
Supervisor
Laura Evans
Todd Lata
Tim Lavey
Steve Macenczak
Lou Mancine
Rick Quayle
Tammy Tokos
Larry Williams
Metals
Aaron Martin
Supervisor
Karen Counts
Dale Elshaw
Dave Heakin
Aaron Sutherland
Natalie Toth
Roger Toth
General Chemistry
Lucas Grossman
Supervisor
Jill Burns
Nicholas Elkelberry
Tom Harshman
Julie Kuhle
Willis Lecorchick
Robert Maggiore
Laura Nolle
Anjali Sharma (T)
Bruce Woodward
Extractions
Chris Coast
Supervisor
Keith Click
Steve Earle
Sean Hunter (T)
Diane Jones
Matthew Moore
Rachel Reed
Matthew Tuttle
Jenae Linville (T)
Nate Brumbaugh (T)
Elizabeth Border
Full Time 94
Part Time (P) 1
Temp (T) 5
* Listed under multiple groups
Note: QA Manager, EH&S Manager, CSO team members have a direct reporting relationship to both operations leadership and corporate functional leadership. Regional staff assigned to lab are included in headcount. Corporate operations & finance staff are excluded from lab headcount.
Effective: 6-17-14

5. QUALITY SYSTEM

5.1. Quality Policy Statement

5.2. It is TestAmerica's policy to:

5.2.1. Provide data of know quality to its clients by adhering to approved methodologies, regulatory requirements, and the QA/QC protocols.

5.2.2. Effectively manage all aspects of the laboratory and business operations by the highest ethical standards.

5.2.3. Continually improve systems and provide support to quality improvement efforts in laboratory, administrative, and managerial activities. TestAmerica recognizes that the implementation of a QAprogram requires management's commitment and support as well as the involvement of the entire staff.

5.2.4. Provide clients with the highest level of professionalism and the best service practices in the industry.

5.2.5. Comply with the ISO/IEC 17025:2005(E) International Standard, the 2009 TNI Standard, and to continually improve the effectiveness of the management system.

5.2.6. Every staff member at the laboratory plays an integral part in quality assurance and is held responsible and accountable for the quality of their work. It is, therefore, required that all laboratory personnel are trained and agree to comply with applicable procedures and requirements established by this document.

5.3. Ethics and Data Integrity

5.3.1. TestAmerica is committed to ensuring the integrity of its data and meeting the quality needs of its clients. The elements of the TestAmerica Ethics and Data Integrity Program include:

5.3.2. An Ethics Policy (Corporate Policy CW-L-P-004) and Employee Ethics Statements (Appendix 1)

5.3.3. Ethics and Compliance Officers (ECOs)

5.3.4. A training program

5.3.5. Self-governance through disciplinary action for violations

5.3.6. A confidential mechanism for anonymously reporting alleged misconduct and a means for conducting internal investigations of all alleged misconduct (Corporate SOP CW-L-S-002)

5.3.7. Procedures and guidance for recalling data if necessary (Corporate SOP CW-L-S-002)

5.3.8. Effective external and internal monitoring system that includes procedures for internal audits (Section 16)

5.3.9. Production of results which are accurate and include QA/QC information that meets client pre-defined Data Quality Objectives (DQOs).

5.3.10. Presenting services in a confidential, honest, and forthright manner.

5.3.11. Providing employees with guidelines and an understanding of the Ethical and Quality Standards of our Industry.

5.3.12. Operating our facilities in a manner that protects the environment and the health and safety of employees and the public.

5.3.13. Obeying all pertinent federal, state, and local laws and regulations and encourage other members of our industry to do the same.

5.3.14. Educating clients as to the extent and kinds of services available.

5.3.15. Asserting competency only for work for which adequate personnel and equipment are available and for which adequate preparation has been made.

5.3.16. Promoting the status of environmental laboratories, their employees, and the value of services rendered by them.

5.4. Quality System Documentation

5.4.1. The laboratory's Quality System is communicated through a variety of documents

5.4.1.1. Quality Assurance Manual – Each laboratory has a lab-specific Quality Assurance Manual.

5.4.1.2. Corporate SOPs and Policies - Corporate SOPs and Policies are developed for use by all relevant laboratories. They are incorporated into the laboratory's normal SOP distribution, training and tracking system. Corporate SOPs may be general or technical.

5.4.1.3. Work Instructions - A subset of procedural steps, tasks, or forms associated with an operation of a management system, e.g., checklists, preformatted bench sheets, forms.

5.4.1.4. Laboratory SOPs – General and technical

5.4.1.5. Laboratory QA/QC Policy Memorandums

5.5. Order of Precedence

5.5.1. In the event of a conflict or discrepancy between policies, the order of precedence is as follows:

5.5.1.1. Corporate Quality Management Plan (CQMP)

5.5.1.2. Corporate SOPs and Policies

5.5.1.3. Laboratory QA/QC Policy Memorandum

5.5.1.4. Laboratory Quality Assurance Manual (QA Manual)

5.5.1.5. Laboratory SOPs and Policies

5.5.1.6. Other: Work Instructions (WI), memos, flow charts, etc.

Note: The laboratory has the responsibility and authority to operate in compliance with regulatory requirements of the jurisdiction in which the work is performed. Where the CQMP conflicts with those regulatory requirements, the regulatory requirements of the jurisdiction shall hold primacy. The laboratory's QA Manager shall take precedence over the CQMP in those cases.

5.5.2. Any regulatory requirements (e.g.; Ohio VAP, CT RCP, etc) provided in the laboratory specific documents (i.e., QA Manual and SOPs) take precedence over any policies provided in corporate documents.

5.6. QA/QC Objectives for the Measurement of Data

5.6.1. Quality Assurance (QA) and Quality Control (QC) are activities undertaken to achieve the goal of producing data that accurately characterize the sites or materials that have been sampled. QA is generally understood to be more comprehensive than Q C. QA can be defined as the integrated system of activities that ensures that a product or service meets defined standards.

5.6.2. QC is generally understood to be limited to the analyses of samples and to be synonymous with the term "analytical quality control". QC refers to the routine application of statistically based procedures to evaluate and control the accuracy of results from analytical measurements. The QC program includes procedures for estimating and controlling precision and bias and for determining reporting limits.

5.6.3. Request for Proposals (RFPs) and Quality Assurance Project Plans (QAPP) provide a mechanism for the client and the laboratory to discuss the data quality objectives (DQOs) in order to ensure that analytical services closely correspond to client needs. The client is responsible for developing the QAPP. In order to ensure the ability of the laboratory to

meet the DQOs specified in the QAPP, clients are advised to allow time for the laboratory to review the QAPP before being finalized. Additionally, the laboratory must provide support to the client for developing the sections of the QAPP that concern laboratory activities.

5.6.4. Historically, laboratories have described their QC objectives in terms of precision, accuracy, representativeness, comparability, completeness, selectivity, and sensitivity (PARCCSS). Equations to derive relevant QC objectives can be found in the method specific SOPs.

5.6.5. Precision

5.6.5.1. The laboratory objective for precision is to meet the performance for precision demonstrated for the methods on similar samples and to meet data quality objectives of the EPA and/or other regulatory programs. Precision is defined as the degree of reproducibility of measurements under a given set of analytical conditions (exclusive of field sampling variability). Precision is documented on the basis of replicate analysis, usually duplicate or matrix spike (MS) and/or matrixspike duplicate(MSD)samples.

5.6.6. Accuracy

5.6.6.1. The laboratory objective for accuracy is to meet the performance for accuracy demonstrated for the methods on similar samples and to meet DQOs of the EPA and/or other regulatory programs. Accuracy is defined as the degree of bias in a measurement system. Accuracy may be documented through the use of laboratory control samples (LCS) and/or MS. A statement of accuracy is expressed as an interval of acceptable recovery centered on the mean recovery.

5.6.7. Representativeness

5.6.7.1. The laboratory objective for representativeness is to provide data which is representative of the sampled medium. Representativeness is defined as the degree to which data represent a characteristic of a population or set of samples and is a measurement of both analytical and field sampling precision. The representativeness of the analytical data is a function of the procedures used in procuring and processing the samples. The representativeness can be documented by the relative percent difference (RPD) between separately procured, but otherwise identical, samples or sample aliquots.

5.6.7.2. The representativeness of the data from the sampling sites depends on both the sampling procedures and the analytical procedures. The laboratory may provide guidance to the client regarding proper sampling and handling methods in order to assure the integrity of the samples.

5.6.8. Comparability

5.6.8.1. The comparability objective is to provide analytical data for which the accuracy, precision, representativeness, and reporting limit statistics are similar to these quality indicators generated by other laboratories for similar samples, and data generated by the same laboratory over time.

5.6.8.2. The comparability objective is documented by inter-laboratory studies carried out by regulatory agencies or carried out for specific projects or contracts, by comparison of periodically generated statements of accuracy, precision, and reporting limits with those of other laboratories.

5.6.9. Completeness

5.6.9.1. The completeness objective for data is 90% (or as specified by a particular project) expressed as the ratio of the valid data to the total data over the course of the project. Data will be considered valid if they are adequate for their intended use. Data usability must be defined in a QAPP, project scope, or regulatory requirement. Data validation is the process for reviewing data to determine its usability and completeness. If the completeness objective is not met, actions will be taken internally and with the data user to improve performance. This may take the form of an audit to evaluate the methodology and procedures as possible sources for the difficulty or may result in a recommendation to use a different method.

5.6.10. Selectivity

5.6.10.1. Selectivity is defined as the capability of a test method or instrument to respond to a target substance or constituent in the presence of non-target substances. Target analytes are separated from non-target constituents and subsequently identified/detected through one or more of the following, depending on the analytical method: extractions (separation), digestions (separation), inter-element corrections (separation), use of matrix modifiers (separation), specific retention times (separation and identification), confirmations with different columns or detectors (separation and identification), specific wavelengths (identification), specific mass spectra (identification), specific electrodes (separation and identification), etc.

5.6.11. Sensitivity

5.6.11.1. Sensitivity refers to the amount of analyte necessary to produce a detector response that can be reliably detected (Method Detection Limit [MDL]) or quantified (Reporting Limit [RL]).

5.7. Criteria for Quality Indicators

5.7.1. The laboratory maintains Quality Control Limits in LIMS that summarize the precision and accuracy acceptability limits for performed analyses. These summaries include an effective date, are updated each time new limits are generated, and are managed by the laboratory's QA Department. Unless otherwise noted, limits within these tables are laboratory generated. Some acceptability limits are derived from US EPA methods when they are required. Where U.S. EPA method limits are not required, the laboratory has developed limits from evaluation of data from similar matrices. Criteria for development of control limits are contained in NC-QA-018 Statistical Evaluation of Data and Development of Control Charts and in Section 24).

5.8. Statistical Quality Control

5.8.1. Statistically-derived precision and accuracy limits are required by selected methods (such as SW-846) and programs. The laboratory routinely utilizes statistically-derived limits to evaluate method performance and determine when corrective action is appropriate. The analysts are instructed to use the current limits in the laboratory (dated and approved by the Group Leader and QA Manager) and entered into LIMS. An archive of all limits used within the laboratory is maintained in the LIMS. If a method defines the QC limits, the method limits are used.

5.8.2. If a method requires the generation of historical limits, the lab develops such limits from recent data in the QC database of the LIMS following the guidelines described in Section 25. All calculations and limits are documented and dated when approved and effective. On occasion, a client requests contract-specified limits for a specific project.

5.8.3. Current QC limits are entered and maintained in the LIMS analyte database. As sample results and the related QC are entered into LIMS, the sample QC values are compared with the limits in LIMS to determine if they are within the acceptable range. If one or more QC values are outside of limits, the analyst then evaluates whether the sample needs to be rerun or re-extracted/rerun or if a comment should be added to the report explaining the reason for the QC outlier.

5.9. QC Charts

5.9.1. The laboratory's procedures for the creation of control charts are described in laboratory SOP No. NC-QA-018, "Statistical Evaluation of Data and Development of Control Charts." Control charts are created from data stored in the LIMS. The charts are evaluated by QA or technical staff to determine if limits need to be updated or to assess the need for corrective actions to improve method performance.

5.9.2. Control charts are used to develop control limits, trouble-shoot analytical problems, and, in conjunction with the non-conformance system, to monitor for trends. Program-specific data analysis requirements for

control charts are followed as required for data generated under those programs. These additional requirements shall be documented in a QAPP.

5.10. Quality System Metrics

5.10.1. In addition to the QC parameters discussed above, the entire Quality System is evaluated on a monthly basis through the use of specific metrics (refer to Section 16). These metrics are used to drive continuous improvement in the laboratory's Quality System.

6. DOCUMENT CONTROL

6.1. Overview

6.1.1. The QA Department is responsible for the control of documents used in the laboratory to ensure that approved, up-to-date documents are in circulation and out-of-date (obsolete) documents are archived or destroyed. The following documents, at a minimum, must be controlled at each laboratory Facility:

6.1.1.1. Laboratory Quality Assurance Manual

6.1.1.2. Laboratory Standard Operating Procedures (SOP)

6.1.1.3. Laboratory Policies

6.1.1.4. Work Instructions and Forms

6.1.1.5. Laboratory spreadsheets used for calibration and analysis

6.1.1.6. Corporate Policies and Procedures distributed outside the intranet

6.1.2. Corporate Quality posts Corporate Manuals, SOPs, Policies, Work Instructions, White Papers, and Training Materials on the company intranet site. These Corporate documents are only considered controlled when they are read on the company intranet site. Printed copies are considered uncontrolled unless the laboratory physically distributes them as controlled documents. A detailed description of the procedure for issuing, authorizing, controlling, distributing, and archiving Corporate documents is found in Corporate SOP CW-Q-S-001, Corporate Document Control and Archiving. The laboratory's internal document control procedure is defined in SOP NC-QA-030, "Document Control" and SOP NC-QA-027, "Preparation and Management of Standard Operating Procedures."

6.1.3. The laboratory QA Department also maintains access to various references and document sources integral to the operation of the laboratory. This includes reference methods and regulations. The laboratory also maintains instrument manuals (hard or electronic copies).

These documents are maintained on the public drive in a document control master database.

6.1.4. The QA department maintains control of supporting records such as audit reports and responses, logbooks, standard logs, Ethics and QA training files, MDL studies, PT studies, certifications and related correspondence, and corrective action reports. Raw analytical data, consisting of bound logbooks, instrument printouts, any other notes, technical training files, magnetic media, electronic data, and final reports are retained electronically by each analytical section, the QA department, or on the company servers.

6.2. Document Approval and Issue

6.2.1. The pertinent elements of a document control system for each document include a unique document title and number, pagination, the total number of pages of the item, the effective date, revision number, and the laboratory name and facility. The QA Department is responsible for the maintenance of this system.

6.2.2. Controlled documents are authorized by the QA Department and members of management. In order to develop a new document, a staff member submits a draft to the QA Department for comments, changes, and approval before use. Upon approval, QA personnel add the identifying version information to the document and retain that document as the official document on file. The document is then provided to all applicable operational units (may include electronic access). Controlled documents are identified as such and records of their distribution are kept by the QA Department. Document control may be achieved by either electronic or hardcopy distribution (see SOP NC-QA-027 for more information).

6.2.3. The QA Department maintains a list of the official versions of controlled documents in the document control database.

6.2.4. Quality System Policies and Procedures must be reviewed at a minimum of every 24 months, and revised as appropriate. For procedures associated with DoD and Ohio VAP project work, applicable SOPs and Policies are reviewed every 12 months. Changes to documents occur when a procedural change warrants.

6.3. Procedures for Document Control Policy

6.3.1. For changes to the QA Manual, refer to SOPs NC-QA-019 and CW-Q-S-001. Uncontrolled copies must not be used within the laboratory. Previous revisions are stored electronically by the QA Department on the public server in the QAQC folder for the applicable revision. The current revision is located in the public controlled document folder accessible to all employees.

6.3.2. For changes to SOPs, refer to Corporate SOP CW-Q-S-002, Writing a Standard Operating Procedure (SOP), and SOP NC-QA-027, Preparation and Management of Standard Operating Procedures. The SOP identified above also defines the process of changes to SOPs.

6.3.3. Forms, worksheets, work instructions, electronic spreadsheets, logbooks, and information are identified and organized by the QA department in accordance with the procedures specified in laboratory SOPNC-QA-027.

6.4. Obsolete Documents

6.4.1. All invalid or obsolete documents are removed, or otherwise prevented from unintended use. The laboratory has specific procedures as described above to accomplish this. In general, hard copies of obsolete documents are collected from employees according to distribution lists and are marked obsolete on the cover or destroyed. At least one copy of the obsolete document is archived in accordance with SOP NC-QA-027.

7. SERVICE TO THE CLIENT

7.1. Overview

7.1.1. The laboratory has established procedures for the review of work requests and contracts, oral or written. The procedures include evaluation of the laboratory's capability and resources to meet the contract's requirements within the requested time period. All requirements, including the methods to be used, must be adequately defined, documented and understood. For many environmental sampling and analysis programs, testing design is site or program specific and does not necessarily "fit" into a standard laboratory service or product. It is the laboratory's intent to provide both standard and customized environmental laboratory services to our clients.

7.1.2. A thorough review of technical and QC requirements contained in contracts is performed to ensure project success. The appropriateness of requested methods, and the lab's capability to perform them must be established. Projects, proposals and contracts are reviewed for adequately defined requirements and the laboratory's capability to meet those requirements. Alternate test methods that are capable of meeting the clients' requirements may be proposed by the lab. A review of the lab's capability to analyze non-routine analytes is also part of this review process.

7.1.3. All projects, proposals and contracts are reviewed for the client's requirements in terms of compound lists, test methodology requested, turnaround time, sensitivity (detection and reporting levels), accuracy, and precision requirements (Recovery [%R] and RPD). The reviewer ensures that the laboratory's test methods are suitable to achieve these requirements and that the laboratory holds the appropriate certifications and approvals to perform the work. The laboratory and any potential

subcontract laboratories must be certified, as required, for all proposed tests.

7.1.4. The laboratory must determine if it has the necessary physical, personnel, and information resources to meet the contract, and if the personnel have the expertise needed to perform the testing requested. Each proposal is checked for its impact on the capacity of the laboratory's equipment and personnel. As part of the review, the proposed turnaround time must be checked for feasibility.

7.1.5. Electronic or hard-copy deliverable requirements are evaluated against the laboratory's capacity for production of the documentation.

7.1.6. If the laboratory cannot provide all services but intends to subcontract such services, whether to another TestAmerica facility or to an outside firm, this must be documented and discussed with the client prior to contract approval (refer to Section 8 for Subcontracting Procedures).

7.1.7. The laboratory informs the client of the results of the review and whether any potential conflict, deficiency, lack of accreditation, or inability of the lab to complete the work satisfactorily is indicated. Any discrepancy between the client's requirements and the laboratory's capability to meet those requirements is resolved in writing before acceptance of the contract. It is necessary that the contract be acceptable to both the laboratory and the client. Amendments initiated by the client and/or TestAmerica, are documented in writing.

7.1.8. All contracts, QAPPs, Sampling and Analysis Plans (SAPs), contract amendments, and documented communications become part of the project record.

7.1.9. The same contract review process used for the initial review is repeated when there are amendments to the original contract by the client, and the participating personnel are informed of the changes.

7.2. Review Sequence and Key Personnel

7.2.1. Appropriate personnel must review the work request at each stage of evaluation.

7.2.2. For routine projects and other simple tasks, a review by the Project Manager (PM) is considered adequate. The PM confirms that the laboratory has any required certifications, that it can meet the clients' data quality and reporting requirements and that the lab has the capacity to meet the clients turn around needs. It is recommended that, where there is a sales person assigned to the account, an attempt should be made to contact that sales person to inform them of the incoming samples.

7.2.3. For new, complex or large projects, the opportunity is forwarded to a Customer Service Manager (CSM) for review. The CSM contacts the appropriate Sales Executive (National Account Manager, Key Account

Executive, Regional Account Executive, and/or Program Manager) to determine which lab will receive the work based on the scope of work and other requirements, including certification, testing methodology, reporting specifications, and available capacity to perform the work. The contract review process is outlined in TestAmerica's Corporate SOP CA-L-P-002, Contract Compliance Policy.

7.2.4. This review encompasses all facets of the operation. The scope of work is distributed to the appropriate personnel, based on scope of contract, to evaluate all of the requirements shown above (not necessarily in this order):

7.2.4.1. Contract Administrator

7.2.4.2. Laboratory Client Service Manager

7.2.4.3. Laboratory Project Manager

7.2.4.4. Laboratory and/or Corporate Technical Director

7.2.4.5. Laboratory and/or Corporate Information Technology Managers/Directors

7.2.4.6. Regional and/or National Account representatives

7.2.4.7. Laboratory and/or Corporate Quality Assurance Managers

7.2.4.8. Laboratory and/or Corporate Environmental Health and Safety Managers/Directors

7.2.4.9. The Laboratory Director reviews the formal laboratory quote, and makes final acceptance for their facility.

7.2.4.10. Based on the level of discount extended for the project, approval of the VP of Operations or Sales Director may also be required.

7.2.4.11. The Sales Director, Contract Administrator, Account Executive, or Proposal Coordinator then submits the final proposal to the client.

7.2.4.12. In the event that one of the above personnel is not available to review the contract, his or her backup will fulfill the review requirements.

7.2.4.13. The Contracts Department (or their designee) maintains copies of all signed contracts. The Laboratory Director also maintains an electronic copy of any contract signed at the local level.

7.3. Documentation

7.3.1. Appropriate records are maintained for every contract or work request. All stages of the contract review process are documented and include records of any significant changes. Documents are reviewed by the Laboratory Director and stored on the laboratory's public drive.

7.3.2. The contract must be distributed to and maintained by the Corporate Contracts Department and the applicable Account Executive. A copy of the contract must be filed electronically by the Laboratory Director. Quotes must be archived electronically in the laboratory quote module in TALs or in the public shared drive if an off-TALs quote is submitted.

7.3.3. Records are maintained of pertinent discussions with a client relating to the client's requirements or the results of the work during the period of execution of the contract. The PM keeps email records or a phone log of conversations with the client.

7.3.4. Project-Specific Quality Planning

7.3.4.1. Communication of contract-specific technical and QC criteria is an essential activity in ensuring the success of site specific testing programs. To achieve this goal, the laboratory assigns a PM to each client. The PM is the first point of contact for the client. It is the PM's responsibility to ensure that project specific technical and QC requirements are effectively evaluated and communicated to the laboratory personnel before and during the project. QA department involvement may be needed to assist in the evaluation of custom QC requirements.

7.3.4.2. PM's are the primary client contact and they ensure resources are available to meet project requirements. Although PM's do not have direct reports or staff in production, they coordinate opportunities and work with laboratory management and supervisory staff to ensure available resources are sufficient to perform work for the client's project. Project management is positioned between the client and laboratory resources.

7.3.4.3. Prior to work on a new project, the dissemination of project information and/or project opening meetings may occur to discuss schedules and unique aspects of the project. Items to be discussed may include the project technical profile, turnaround times, holding times, methods, analyte lists, reporting limits, deliverables, sample hazards, or other special requirements. The PM introduces new projects to the laboratory staff through project kick-off meetings or to the supervisory staff during production meetings. These meetings provide direction to the laboratory staff in order to maximize production and client satisfaction, while maintaining quality. In addition, project notes may be associated with each sample batch as a reminder upon sample receipt and analytical processing.

7.3.4.4. During the project, any change that may occur within an active project is agreed upon between the client/regulatory agency and the PM/laboratory. These changes, e.g., use of a non-standard method or modification of a method, and approvals must be documented prior to implementation. Documentation pertains to any document, e.g., letter, e-mail, variance, contract addendum, which has been signed by both parties.

7.3.4.5. Such changes are also communicated to the laboratory. Project-specific changes made after samples are in-house are communicated through Change Information Notification emails

7.3.4.6. Programmatic and/or method changes are communicated via email transmittal and/or in meetings with the applicable Operations Managers. If the modification includes use of a non-standard method, or significant modification of a method, documentation of the modification is made in the case narrative of the applicable data report(s).

7.3.4.7. The laboratory strongly encourages client visits to the laboratory and for formal/informal information sharing session with employees in order to effectively communicate ongoing client needs as well as project specific details for customized testing programs.

7.4. Special Services

7.4.1. The laboratory cooperates with clients and their representatives to monitor the laboratory's performance in relation to work performed for the client. It is the laboratory's goal to meet all client requirements in addition to statutory and regulatory requirements. The laboratory has procedures to ensure confidentiality to clients (Section 15 and 25).

Note: ISO/IEC 17025:2005(E) states that a laboratory "shall afford clients or their representatives' cooperation to clarify the client's request". This topic is discussed in Section 7 of the ISO standard.

7.4.2. The laboratory's standard procedures for reporting data are described in Section 25. Special services are also available and provided upon request. These services include:

7.4.3. Reasonable access for our clients or their representatives to the relevant areas of the laboratory for the witnessing of tests performed for the client.

7.4.4. Assist client-specified third-party data validators as specified in the client's contract.

7.4.5. Supplemental information pertaining to the analysis of their samples. Note: An additional charge may apply for additional data/information that was not requested prior to the time of sample analysis or previously agreed upon.

7.5. Client Communication

7.5.1. Customer Service Managers (CSMs) and Project Managers (PMs) are the primary communication link to the clients. They must inform their clients of any delays in project completion as well as any non-conformances in either sample receipt or sample analysis. Project Management must maintain ongoing client communication throughout the entire client project.

7.5.2. The Technical Director, Operation Manager, QA Manager or Group Leaders are available to discuss any technical questions or concerns the client may have.

7.6. Reporting

7.6.1. The laboratory works with our clients to produce any special communication reports required by the contract.

7.7. Client Surveys

7.7.1. The laboratory assesses both positive and negative client feedback. The results are used to improve overall laboratory quality and client service. TestAmerica Sales and Marketing teams periodically develop lab and client-specific surveys to assess client satisfaction.

8. SUBCONTRACTING OF TESTS

8.1. Overview

8.1.1. For the purpose of this quality manual, the phrase subcontract laboratory refers to a laboratory external to the TestAmerica Laboratories. The phrase “work sharing” refers to internal transfers of samples between the TestAmerica Laboratories. The term “outsourcing” refers to the act of subcontracting tests to external laboratories or laboratories within the TestAmerica network.

8.1.2. When contracting with our clients, the laboratory makes commitments regarding the services to be performed and the data quality for the results to be generated. When the need arises to outsource testing for our clients because project scope, changes in laboratory capabilities, capacity or unforeseen circumstances, we must be assured that the subcontractors or work sharing laboratories understand the requirements and meet the same commitments we have made to the client. Refer to TestAmerica’s Corporate SOPs on Subcontracting Procedures (CA-L-S-002).

8.1.3. When outsourcing analytical services, the laboratory must assure, to the extent necessary, that the subcontract or work sharing laboratory maintains a program consistent with the requirements of this document, the requirements specified in TNI ISO/IEC 17025:2005(E) and/or the client’s Quality Assurance Project Plan (QAPP). All QC guidelines specific to the client’s analytical program are transmitted to the subcontractor and

agreed upon before sending the samples to the subcontract facility. Additionally, work requiring accreditation must be placed with an appropriately accredited laboratory. In all cases, TNI accredited as well as non-TNI, the laboratory performing the subcontracted work must be identified in the final report.

8.1.4. For DoD projects, the subcontractor laboratories used must have an established and documented laboratory quality system that complies with DoD QSM requirements. The subcontractor laboratories are evaluated following the procedures outlined below and as seen in Figure 8-1. The subcontractor laboratory must receive project-specific approval from the DoD client before any samples are analyzed.

8.1.5. The QSM has five specific requirements for subcontracting:

8.1.5.1. Subcontractor laboratories must have an established laboratory quality system that complies with the QSM.

8.1.5.2. Subcontractor laboratories must be approved by the specific DoD component laboratory approval process (outlined in the QSM).

8.1.5.3. Subcontractor laboratories must demonstrate the ability to generate acceptable results from the analysis of PT samples, subject to availability, using each applicable method, in the specified matrix, and provide appropriate documentation to the DoD client.

8.1.5.4. Subcontractor laboratories must receive project-specific approval from the DoD client before any samples are analyzed.

8.1.5.5. Subcontractor laboratories are subject to project-specific, on-site assessments by the DoD client or their designated representatives.

8.1.6. PMs or Client Service Managers (CSM) or Account Executives (AE) (or others as defined by the lab) for the Export Lab (TestAmerica laboratory that transfers samples to another laboratory) are responsible for obtaining client approval prior to subcontracting samples to another laboratory) are are responsible for obtaining client approval prior to outsourcing any samples. The laboratory must advise the client of a subcontract or work sharing arrangement in writing and, when possible, approval from the client must be retained in the project folder.

Note: In addition to the client, some regulating agencies (e.g., USDA) or contracts (e.g., certain USACE projects) may require notification prior to placing such work.

8.2. Qualifying and Monitoring Subcontractors

8.2.1. Whenever a PM or CSM becomes aware of a client requirement or laboratory need where samples must be outsourced to another laboratory, the other laboratory(s) shall be selected based on the following:

8.2.1.1. The first priority is to attempt to place the work in a qualified TestAmerica laboratory

8.2.1.2. Firms specified by the client for the task. (Documentation that a subcontractor was designated by the client must be maintained with the project file. This documentation can be as simple as placing a copy of an e-mail from the client in the project folder.)

8.2.1.3. Firms listed as pre-qualified and currently under a subcontract with TestAmerica. A listing of all approved subcontracting laboratories is available on the TestAmerica intranet site. Supporting documentation is maintained by Corporate offices and by the TestAmerica laboratory originally requesting approval of the subcontract lab. Verify necessary accreditation, where applicable (e.g., on the subcontractors TNI, A2LA accreditation, or State Certification).

8.2.1.4. Firms identified in accordance with the company's Small Business Subcontracting program as small, women-owned, veteran-owned and/or minority-owned businesses

8.2.1.5. TNI or A2LA-accredited laboratories

8.2.2. In addition, the firm must hold the appropriate certification to perform the work required

8.2.3. All TestAmerica Laboratories are pre-qualified for work sharing, provided they hold the appropriate accreditations, can adhere to the project/program requirements, and the client approved sending samples to that laboratory. The client must provide acknowledgement that the samples can be sent to that facility (an e-mail is sufficient documentation or if acknowledgement is verbal, the date, time, and name of person providing acknowledgement must be documented). The originating laboratory is responsible for communicating all technical, quality, and deliverable requirements as well as other contract needs. Refer to Corporate SOP CA-C-S-001, "Work Sharing Process."

8.2.4. When the potential subcontract laboratory has not been previously approved, CRMs or PMs may nominate a laboratory as a subcontractor based on need. The decision to nominate a laboratory must be approved by the Laboratory Director. The Laboratory Director requests that the QA Manager begin the process of approving the subcontract laboratory as outlined in Corporate SOP CA-L-S-002, Subcontracting Procedures. The client must provide acknowledgement that the samples can be sent to

that facility. (An e-mail is sufficient documentation; or if acknowledgement is verbal, the date, time, and name of person providing acknowledgement must be documented.)

8.2.5. Once the appropriate accreditation and legal information is received by the laboratory, it is evaluated for acceptability (where applicable) and forwarded to the Corporate Quality Information Manager for review. Once all documents are reviewed for completeness, the Corporate QI Manager will forward the documents to the Purchasing Manager for formal signature and contractive with the laboratory. The approved vendor will be added to the subcontractor list on the intranet site, and the Finance Group is concurrently notified for J.D.Edwards.

8.2.6. The client must assume responsibility for the quality of the data generated from the use of a subcontractor they have requested the lab to use. The qualified subcontractors on the intranet site are to meet minimal standards. TestAmerica does not certify laboratories. The subcontractor is on our approved list, and can only be recommended to the extent that we would use them.

8.2.7. The status and performance of qualified subcontractors must be monitored periodically by the Corporate Contracts and/or Quality Departments. Any problems identified must be brought to the attention of TestAmerica's Corporate Finance or Corporate Quality personnel.

8.2.8. Complaints must be investigated. Documentation of the complaint, investigation, and corrective action must be maintained in the subcontractor file on the intranet site. Complaints are posted using the Vendor Performance Report.

8.2.9. Information must be updated on the intranet when new information is received from the subcontracted laboratories.

8.2.10. Subcontractors in good standing must be retained on the intranet listing. The QA Manager must notify all TestAmerica laboratories, Corporate Quality, and Corporate Contracts if any laboratory requires removal from the intranet site. This notification must be posted on the intranet site and e-mailed to all Laboratory Directors, QA Managers, and Sales Personnel.

8.3. Oversight and Reporting

8.3.1. The CRM or PM must request that the selected subcontractor be presented with a subcontract, if one is not already executed between the laboratory and the subcontractor. The subcontract must include terms which reflect the requirements of our clients, either in the subcontract itself or through the mechanism of work orders relating to individual projects. A standard subcontract and the Lab Subcontractor Vendor Package (posted on the intranet) can be used to accomplish this, and the Legal & Contracts Director can tailor the document or assist with negotiations, if needed. The CRM or PM responsible for the project must advise and obtain client consent to the subcontract as appropriate, and

provide the scope of work to ensure that the proper requirements are made a part of the subcontract and are made known to the subcontractor.

8.3.2. Prior to sending samples to the subcontracted laboratory, the PM confirms their certification status to determine if it's current and scope-inclusive. The information is documented and retained in the project folder. For TestAmerica Laboratories, certifications can be viewed on the company's TotalAccess Database.

8.3.3. The Sample Control Department is responsible for ensuring compliance with QA requirements and applicable shipping regulations when shipping samples to a subcontracted laboratory.

8.3.4. All subcontracted samples must be accompanied by a TestAmerica Chain of Custody (COC). A copy of the original COC sent by the client must also be included with all samples workshared within TestAmerica. Client COCs are only forwarded to external subcontractors when samples are shipped directly from the project site to the subcontractor lab. Under routine circumstances, client COCs are not provided to external subcontractors.

8.3.5. Through communication with the subcontracted laboratory, the PM monitors the status of the subcontracted analyses, facilitates successful execution of the work, and ensures the timeliness and completeness of the analytical report.

8.3.6. Non-TNI accredited work must be identified in the subcontractor's report as non-TNI accredited work. If TNI accreditation is not required for the project, the report does not need to include this information.

8.3.7. Reports submitted from subcontractor laboratories are not altered and are included in their original form in the final project report. This clearly identifies the data as being produced by a subcontractor facility. If subcontract laboratory data is incorporated into the laboratory EDD, i.e., imported, the report must explicitly indicate the specific lab that produced the data and identify the specific methods and samples.

Note: The results submitted by a TestAmerica work-sharing laboratory may be transferred electronically and the results reported by the TestAmerica work-sharing lab are identified on the final report. The report must explicitly indicate which lab produced the data for which methods and samples. The final report must include a copy of the completed COC for all work sharing reports.

8.4. Contingency Planning

8.4.1. The Laboratory Director may waive the full qualification of a subcontractor process temporarily to meet emergency needs; however, this decision and justification must be documented in the project files, and the "Purchase Order Terms and Conditions for Subcontracted Laboratory Services" must be sent with the samples and Chain-of-Custody. In the

event this provision is utilized, the laboratory (e.g., QA Manager) will be required to verify and document the applicable accreditations of the subcontractor. All other quality and accreditation requirements will still be applicable, but the subcontractor need not have signed a subcontract with TestAmerica at this time. The comprehensive approval process must then be initiated within 30 calendar days of subcontracting.

9. PURCHASING SERVICES AND SUPPLIES

9.1. Overview

9.1.1. Evaluation and selection of suppliers and vendors is performed, in part, on the basis of the quality of their products, their ability to meet laboratory demand on a continuous and short term basis, the overall quality of their services, their past history, and competitive pricing. This is achieved through evaluation of objective evidence of quality furnished by the supplier, which can include certificates of analysis, recommendations, and proof of historical compliance with similar programs for other clients. To ensure that quality critical consumables and equipment conform to specified requirements, which may affect quality, all purchases from specific vendors are approved by a member of the supervisory or management staff. Capital expenditures are made in accordance with TestAmerica's Corporate Controlled Purchases Procedure, SOP CW-F-S-007.

9.1.2. Contracts must be signed in accordance with TestAmerica's Corporate Authorization Matrix Policy, Policy CW-F-P-002. Request for Proposals (RFP's) must be issued when more information is required from the potential vendors than just price. Process details are available in TestAmerica's Corporate Procurement and Contracts Policy (Policy CW-F-P-004). RFP's allow TestAmerica to determine if a vendor is capable of meeting requirements such as supplying all of the TestAmerica facilities, meeting required quality standards and adhering to necessary ethical and environmental standards. The RFP process also allows potential vendors to outline any additional capabilities they may offer.

9.2. Glassware

9.2.1. Glassware used for volumetric measurements must be Class A or verified for accuracy according to laboratory procedure. Pyrex (or equivalent) glass must be used where possible. For safety purposes, thick-wall glassware must be used where available.

9.3. Reagents, Standards & Supplies

9.3.1. Purchasing guidelines for equipment and reagents must meet the requirements of the specific method and testing procedures for which they are being purchased. Solvents and acids are pre-tested in accordance with TestAmerica's Corporate SOP on Solvent and Acid Lot Testing and Approval, SOP CA-Q-S-001.

9.4. Purchasing

9.4.1. Chemical reagents, solvents, glassware, and general supplies are ordered as needed to maintain sufficient quantities on hand. Materials used in the analytical process must be of a known quality. The wide variety of materials and reagents available makes it advisable to specify recommendations for the name, brand, and grade of materials to be used in any determination. This information is contained in the method SOP. The analyst may check the item out of the on-site consignment system that contains items approved for laboratory use. If the item is not in consignment, the analyst must provide the master item number, item description, package size, catalogue page number, and the quantity needed. If an item being ordered is not the exact item requested, approval must be obtained from the Operations Manager or Group Leader prior to placing the order. The purchasing manager places the order.

9.5. Receiving

9.5.1. It is the responsibility of the Warehouse Manager to receive the shipment. It is the responsibility of the analyst who ordered the materials to document the date materials were received. Once the ordered reagents or materials are received, the analyst compares the information on the label or packaging to the original order to ensure that the purchase meets the quality level specified. Safety Data Sheets (SDSs) are kept on a backup disc located in the Wet Chemistry bullpen and available online through the Company's intranet website. Anyone may review these for relevant information on the safe handling and emergency precautions of on-site chemicals.

9.6. Specifications

9.6.1. Methods in use in the laboratory specify the grade of reagent that must be used in the procedure. If the quality of the reagent is not specified, analytical reagent grade will be used. It is the responsibility of the analyst to check the procedure carefully for the suitability of grade of reagent. Specifications are listed in SOP NC-QA-017, Reagents and Standards.

9.6.2. Chemicals must not be used past the manufacturer's expiration date and must not be used past the expiration time noted in a method SOP. If expiration dates are not provided, the laboratory must contact the manufacturer to determine an expiration date.

9.6.3. The laboratory assumes a five-year expiration date on inorganic dry chemicals and solvents, unless noted otherwise by the manufacturer, or by the reference source method. Chemicals/solvents must not be used past the manufacturer's or SOP's expiration date unless "verified" (refer to Item 3 listed below).

9.6.4. An expiration date cannot be extended if the dry chemical/solvent is discolored or appears otherwise physically degraded, the dry chemical/solvent must be discarded.

9.6.5. Expiration dates can be extended if the dry chemical/solvent is found to be satisfactory based on acceptable performance of quality control samples (Continuing Calibration Verification (CCV), Method Blanks, LCS, etc.).

9.6.6. If the dry chemical/solvent is used for the preparation of standards, the expiration dates can be extended six months if the dry chemical/solvent is compared to an unexpired independent source in performing the method and the performance of the dry chemical/solvent is found to be satisfactory. The comparison must show that the dry chemical/solvent meets CCV limits. The comparison studies are maintained in the Reagent module of LIMS for each laboratory group.

9.6.7. Wherever possible, standards must be traceable to national or international standards of measurement or to national or international reference materials. Records to that effect are available to the user.

9.6.8. Compressed gases in use are checked for pressure and secure positioning daily. To prevent a tank from going to dryness, or introducing potential impurities, the pressure should be closely watched as it decreases to approximately 15% of the original reading, at which point it should be replaced. For example, a standard sized laboratory gas cylinder containing 3,000 psig of gas should be replaced when it drops to approximately 500 psig. The quality of the gases must meet method or manufacturer specification or be of a grade that does not cause any analytical interference.

9.6.9. Water used in the preparation of standards or reagents must have a conductivity of less than 1 μmho/cm (or specific resistivity of greater than 1.0 mega ohm/cm) at 25oC. The specific conductivity is checked and recorded daily. If the water's specific conductivity is greater than the specified limit, the Operations Manager and appropriate Technical Manager must be notified immediately in order to notify all departments, decide on cessation (based on intended use) of activities, and make arrangements for correction.

9.6.10. The laboratory may purchase reagent grade (or other similar quality) water for use in the laboratory. This water must be certified "clean" by the supplier for all target analytes or otherwise verified by the laboratory prior to use. This verification is documented.

9.6.11. Standard lots are verified before first time use if the laboratory switches manufacturers or has historically had a problem with the type of standard.

9.6.12. Purchased bottle ware used for sampling must be certified clean, and the certificates must be maintained. If uncertified sampling bottle ware is

purchased, all lots must be verified clean prior to use. This verification must be maintained.

9.7. Storage

9.7.1. Reagent and chemical storage is important from the aspects of both integrity and safety. Light-sensitive reagents may be stored in brown-glass containers. Storage conditions are per the Corporate Environmental Health & Safety Manual (Corporate Document CW-E-M-001) and method SOPs or manufacturer instructions.

9.8. Purchase Of Equipment/Instruments/Software

9.8.1. When a new piece of equipment is needed, either for additional capacity or for replacing inoperable equipment, the analyst or group leader makes a supply request to the Operations Manager and/or the Laboratory Director. If they agree with the request the procedures outlined in TestAmerica's Corporate Policy CA-T-P-001, Qualified Products List, are followed. A decision is made as to which piece of equipment can best satisfy the requirements. The appropriate written requests are completed, and Purchasing places the order.

9.8.2. Upon receipt of a new or used piece of equipment, an identification name is assigned, such as HP-20, and added to the equipment list described in Section 21 that is maintained by the QA Department, and I.T. must be notified so they can synchronize the instrument for backups. Its capability is assessed to determine if it is adequate or not for the specific application. For instruments, a calibration curve is generated followed by MDLs, and other relevant criteria (refer to Section 20). For software, its operation must be deemed reliable and evidence of instrument verification must be retained by the IT Department or QA Department. Software certificates supplied by the vendors are filed with the LIMS Administrator. The manufacturer's operation manual is retained at the bench. All equipment manuals are also recorded in the QA department document tracking system.

9.9. Services

9.9.1. Service to analytical instruments (except analytical balances) is performed on an as-needed basis. Routine preventative maintenance is discussed in Section 20. The need for service is determined by analysts and/or Department Managers. The service providers that perform the services are approved by the Department Managers or Operations Manager.

9.10. Suppliers

9.10.1. TestAmerica selects vendors through a competitive proposal / bid process, strategic business alliances or negotiated vendor partnerships (contracts). This process is defined in the Procurement and Contracts Policy (Policy CW-F-P-004). The level of control used in the selection

process is dependent on the anticipated spending amount and the potential impact on TestAmerica business. Vendors that provide test and measuring equipment, solvents, standards, certified containers, instrument related service contracts or subcontract laboratory services shall be subject to more rigorous controls than vendors that provide off-the-shelf items of defined quality that meet the end use requirements. The JD Edwards purchasing system includes all suppliers /vendors that have been approved for use.

9.10.2. Evaluation of suppliers is accomplished by ensuring the supplier ships the product or material ordered and that the material is of the appropriate quality. This is documented by signing off on packing slips or other supply receipt documents. The purchasing documents contain the data that adequately describe the services and supplies ordered.

9.10.3. Any issues of vendor performance are to be reported immediately by the laboratory staff to the Corporate Purchasing Group by completing a Vendor Performance Report (CW-F-WI-009).

9.10.4. The Corporate Purchasing Group must work through the appropriate channels to gather the information required to clearly identify the problem and must contact the vendor to report the problem and to make any necessary arrangements for exchange, return authorization, credit, etc.

9.10.5. As deemed appropriate, the Vendor Performance Reports must be summarized and reviewed to determine corrective action necessary, or service improvements required by vendors

9.10.6. The laboratory has access to a listing of all approved suppliers of critical consumables, supplies and services. This information is provided through the JD Edwards purchasing system.

9.11. New Vendor Procedure

9.11.1. TestAmerica employees who wish to request the addition of a new vendor must complete a J.D. Edwards Vendor Add Request Form.

9.11.2. New vendors are evaluated based upon criteria appropriate to the products or services provided as well as their ability to provide those products and services at a competitive cost. Vendors are also evaluated to determine if there are ethical reasons or potential conflicts of interest with TestAmerica employees that would make it prohibitive to do business with them as well as their financial stability. The QA Department, Technical Services Director, and/or the Laboratory Director are consulted with vendor and product selection that have an impact on quality.

10. COMPLAINTS

10.1. OVERVIEW

10.1.1. The laboratory considers an effective client complaint handling process to be of significant business and strategic value. Listening to and documenting client concerns captures 'client knowledge' that enables our operations to continually improve processes and improving client satisfaction. An effective client complaint handling process also provides assurance to the data user that the laboratory will stand behind its data, service obligations and products.

10.1.2. A client complaint is any expression of dissatisfaction with any aspect of our business services, (e.g., communications, responsiveness, data, reports, invoicing and other functions) expressed by any party, whether received verbally or in written form. Client inquiries, complaints or noted discrepancies are documented, communicated to management, and addressed promptly and thoroughly.

10.1.3. The laboratory has procedures for addressing both external and internal complaints with the goal of providing satisfactory resolution to complaints in a timely and professional manner.

10.1.4. The nature of the complaint is identified, documented and investigated, and an appropriate action is determined and taken. In cases where a client complaint indicates that an established policy or procedure was not followed, the QA Department must evaluate whether a special audit must be conducted to assist in resolving the issue. A written confirmation or letter to the client, outlining the issue and response taken is recommended as part of the overall action taken.

10.1.5. The process of complaint resolution and documentation utilizes the procedures outlined in Section 12 (Corrective Actions) and is documented following SOPs NC-QA-029, Nonconformance and Corrective Action System, and CA-C-S-002, Complaint Handling and Service Recovery.

10.2. External Complaints

10.2.1. An employee that receives a complaint initiates the complaint resolution process by first documenting the complaint according to CA-C-S-002, Complaint Handling and Service Recovery.

10.2.2. Complaints fall into two categories: correctable and non-correctable. An example of a correctable complaint would be one where a report re-issue would resolve the complaint. An example of a non-correctable complaint would be one where a client complains that their data was repeatedly late. Non-correctable complaints must be reviewed for preventive action measures to reduce the likelihood of future occurrence and mitigation of client impact.

10.2.3. The general steps in the complaint handling process are:

10.2.3.1. Receiving and Documenting Complaints

10.2.3.2. Complaint Investigation and Service Recovery

10.2.3.3. Process Improvement

10.2.4. The laboratory must inform the initiator of the complaint of the results of the investigation and the corrective action taken, if any.

10.2.5. Single event complaints are documented for tracking and trend analysis and initiate a non-conformance notification/memo (NCM). QA is notified and tracks the NCMs for identification of trends or systematic issues. A high-level or repeat complaint will initiate the corrective action process and will be documented with a formal Corrective Action Report (CAR). All client complaints are tracked in the corrective action worksheet maintained by the QA department.

10.3. Internal Complaints

10.3.1. Internal complaints include, but are not limited to errors and non-conformances, training issues, internal audit findings, and deviations from methods. Corrective actions may be initiated by any staff member who observes a nonconformance and must follow the procedures outlined in Section 12. In addition, Corporate Management, Sales and Marketing, and Information Technology (IT) may initiate a complaint by contacting the laboratory or through the Corrective Action system described in Section 12.

10.3.2. All audit findings (internal and external) will initiate the CA process, are documented with a CAR, and are tracked in the QA CA tracking workbook.

10.4. Management Review

10.4.1. The number and nature of client complaints is reported by the QA Manager to the laboratory and QA Director in the QA Monthly report. Monitoring and addressing the overall level and nature of client complaints and the effectiveness of the solutions is part of the Annual Management Review (Section 16)

11. CONTROL OF NON-CONFORMING WORK

11.1. OVERVIEW

11.1.1. When data discrepancies are discovered or deviations and departures from laboratory SOPs, policies, and/or client requests have occurred, corrective action is taken immediately. First, the laboratory evaluates the significance of the nonconforming work. Then, a Corrective Action plan is initiated based on the outcome of the evaluation. If it is determined that the nonconforming work is an isolated incident, the plan could be as simple as adding a qualifier to the final results and/or making a notation in the case narrative. If it is determined that the nonconforming work is a systematic or improper practices issue, the Corrective Action plan could include a more in depth investigation and a possible suspension of an

analytical method. In all cases, the actions taken are documented using the laboratory's Corrective Action system (refer to Section 12).

11.1.2. Due to the frequently unique nature of environmental samples, sometimes departures from documented policies and procedures are needed. When an analyst encounters such a situation, the problem is presented to the supervisor for resolution. The supervisor may elect to discuss it with the Technical Director or have a representative contact the client to decide on a logical course of action. Once an approach is agreed upon, the analyst documents it using the laboratories corrective action system described in Section 12. This information can then be supplied to the client in the form of a footnote or a case narrative with the report.

11.1.3. Project Management may encounter situations where a client may request that a special procedure be applied to a sample that is not standard lab practice. Based on a technical evaluation, the lab may accept or opt to reject the request based on technical or ethical merit. An example might be the need to report a compound that the lab does not normally report. The lab would not have validated the method for this compound following the procedures in Section 19. The client may request that the compound be reported based only on the calibration. Such a request would need to be approved by the Operations Manager and QA Manager, documented and included in the project folder. Deviations must also be noted on the final report with a statement that the compound is not reported in compliance with TNI (or the analytical method) requirements and the reason. Data being reported to a non- TNI state would need to note the change made to how the method is normally run.

11.1.4. Note: The laboratory must implement Corrective Action procedures to resolve the deviation and limit qualification of the final results. The laboratory is not permitted to deviate from its VAP approved SOP if it intends to attest under affidavit that the "results" are VAP certified. When all Corrective Actions listed in the SOP have been exhausted, it may be necessary to use technical judgment in which case the decision process and rationale will be presented in the final report and/or affidavit and the data will be noted as 'not VAP certified' on the affidavit.

11.2. Responsibilities And Authorities

11.2.1. TestAmerica's Corporate SOP entitled Internal Investigation of Potential Data Discrepancies and Determination for Data Recall (SOP CW-L-S-002) outlines the general procedures for the reporting and investigation of data discrepancies and alleged incidents of misconduct or violations of the TestAmerica's data integrity policies as well as the policies and procedures related to the determination of the potential need to recall data.

11.2.2. Under certain circumstances the Laboratory Director, Operations Manager, Project Manager, or a member of the QA team may exceptionally authorize departures from documented procedures or policies. The departures may be a result of procedural changes due to the nature of the sample; a one-time procedure for a client; QC failures with insufficient sample to reanalyze, etc. In most cases, the client must be informed of the departure prior to the reporting of the data. Any departures must be well documented using the laboratory's Corrective Action procedures described in Section 12. This information may also need to be documented in logbooks and/or data review as appropriate. Any impacted data must be referenced in a case narrative and/or flagged with an appropriate data qualifier.

11.2.3. Any misrepresentation or possible misrepresentation of analytical data discovered by any laboratory staff member must be reported to facility Senior Management within 24 hours. The Senior Management staff is compromised of the Laboratory Director, QA Manager, Customer Service Manager, Operations Manager, I.T. Manager, H.R. Manager, PM Manager, and Technical Director. The reporting of issues involving alleged violations of the company's Data Integrity or Manual Integration procedures must be conveyed to an Ethics and Compliance Officer (ECO), Director of Quality and Client Advocacy, and the laboratory's Corporate Quality Director within 24 hours of discovery.

11.2.4. Whether an inaccurate result was reported due to calculation or quantitation errors, data entry errors, improper practices, or failure to follow SOPs, the data must be evaluated to determine the possible effect.

11.2.5. The Laboratory Director, QA Manager, ECOs, Corporate Quality Director, Executive VP of Operations, and the Corporate Quality Directors have the authority and responsibility to halt work, withhold final reports, or suspend an analysis for due cause as well as authorize the resumption of work.

11.3. Evaluation Of Significance And Actions Taken

11.3.1. For each nonconforming issue reported, an evaluation of its significance and the level of management involvement needed is made. This includes reviewing its impact on the final data, whether or not it is an isolated or systematic issue, and how it relates to any special client requirements.

11.3.2. TestAmerica's Corporate Data Investigation and Recall Procedure (SOPCW-L-S-002) distinguishes between situations when it would be appropriate for laboratory management to make the decision on the need for client notification (written or verbal) and data recall (report revision) and when the decision must be made with the assistance of the ECOs and Corporate Management. Laboratory level decisions are documented and approved using the laboratory's standard nonconformance/Corrective Action reporting in lieu of the data recall determination form contained in TestAmerica Corporate SOPCW-L-S-002.

11.4. Prevention Of Nonconforming Work

11.4.1. If it is determined that the nonconforming work could recur, further corrective actions must be made following the laboratory's Corrective Action system. Periodically, as defined by the laboratory's preventive action schedule (monthly), the QA Department evaluates non-conformances to determine if any nonconforming work has been repeated multiple times. If so, the laboratory's Corrective Action process may be followed.

11.5. Method Suspension/Restriction (Stop Work Procedures)

11.5.1. In some cases it may be necessary to suspend/restrict the use of a method or target compound which constitutes significant risk and/or liability to the laboratory. Suspension/restriction procedures can be initiated by any of the persons noted in Section 11.2, Paragraph 5.

11.5.2. Prior to suspension/restriction, confidentiality must be respected, and the problem with the required corrective and preventive action must be stated in writing and presented to the Laboratory Director.

11.5.3. The Laboratory Director must arrange for the appropriate personnel to meet with the QA Manager as needed. This meeting must be held to confirm that there is a problem, that suspension/restriction of the method is required and must be concluded with a discussion of the steps necessary to bring the method/target or test fully back on line. In some cases that may not be necessary if all appropriate personnel have already agreed there is a problem and there is agreement on the steps needed to bring the method, target, or test fully back on line.

11.5.4. The QA Manager must also initiate a Corrective Action report as described in Section 12 if one has not already been started. A copy of any meeting notes and agreed-upon steps should be faxed or e-mailed by the laboratory to the appropriate General Manager and member of Corporate QA. This fax/e-mail acts as notification of the incident.

11.5.5. After suspension/restriction, the lab will hold all reports to clients pending review. No faxing, mailing or distributing through electronic means may occur. The report must not be posted for viewing on the Internet. It is the responsibility of the Laboratory Director to hold all reporting and to notify all relevant laboratory personnel regarding the suspension/restriction, i.e., Project Management, Log-in, etc. Clients must NOT generally be notified at this time. Analysis may proceed in some instances depending on the non-conformance issue.

11.5.6. Within 72 hours, the QA Manager must determine if compliance is now met and reports can be released, OR determine the plan of action to bring work into compliance, and release work. A team, with all principals involved (Laboratory Director, Technical Director, QA Manager, Group Leader) can devise a start-up plan to cover all steps from client notification through compliance and release of reports. Project

Management and the Directors of Client Services and Sales and Marketing must be notified if clients must be notified or if the suspension/restriction affects the laboratory's ability to accept work. The QA Manager must approve start-up or elimination of any restrictions after all corrective action is complete. This approval is given by final signature on the completed Corrective Action report.

12. CORRECTIVE ACTION

12.1. Overview

12.1.1. A major component of TestAmerica's Quality Assurance (QA) Program is the problem investigation and feedback mechanism designed to keep the laboratory staff informed on quality related issues and to provide insight to problem resolution. When nonconforming work or departures from policies and procedures in the quality system or technical operations are identified, the Corrective Action procedure provides a systematic approach to assess the issues, restore the laboratory's system integrity, and prevent reoccurrence. Nonconformance Memos (NCM) are used to document excursions for SOPs, control limits, holding times, etc. A Corrective Action report is used to document and communicate actions taken to investigate, correct, and prevent recurrence of a more significant problem. All incidents are documented and tracked in the QA corrective action database. A brief summary of the system is described below, for more detail refer to SOP NC-QA-029.

12.2. General

12.2.1. Problems within the quality system or within analytical operations may be discovered in a variety of ways, such as QC sample failures, internal or external audits, PT performance, client complaints, staff observation, etc.

12.2.2. The purpose of a Corrective Action system is to:

12.2.2.1. Identify non-conformance events and assign responsibility(s) for investigating.

12.2.2.2. Resolve non-conformance events and assign responsibility for any required corrective action.

12.2.2.3. Identify systematic problems before they become serious.

12.2.2.4. Identify and track client complaints and provide resolution

12.2.2.5. Improve systems and/or processes

12.3. Non-Conformance Memo (NCM)

12.3.1. An NCM is used to document the following types of one-off corrective actions:

12.3.1.1. Deviations from an established procedure or SOP

12.3.1.2. QC outside of limits (non-matrix related)

12.3.1.3. Isolated reporting / calculation errors

12.3.1.4. Client Complaints

12.3.1.5. Discrepancies in materials / goods received vs. manufacturer packing slips

12.4. Corrective Action Report (CAR)

12.4.1. A CAR is used to document the following types of investigations and resulting corrective actions:

12.4.1.1. Questionable trends that are found in the review of NCMs.

12.4.1.2. Issues found while reviewing NCMs that warrant further investigation.

12.4.1.3. Internal and external audit findings

12.4.1.4. Failed or unacceptable PT results.

12.4.1.5. Corrective actions that cross multiple departments in the laboratory.

12.4.1.6. Systematic reporting / calculation errors

12.4.1.7. Client complaints

12.4.1.8. Data recall investigations

12.4.1.9. Identified poor process or method performance trends

12.4.1.10. Excessive revised reports

12.4.2. This will provide background documentation to enable root cause analysis and preventive action.

12.5. Closed Loop Corrective Action Process

12.5.1. Any employee in the company can initiate a Corrective Action. There are four main components to a closed-loop Corrective Action process once an issue has been identified--Cause Analysis, Selection and Implementation of Corrective Actions (both short and long term), Monitoring of the Corrective Actions, and Follow-up.

12.6. Root Cause Analysis

12.6.1. Upon discovery of a non-conformance event, the event must be defined and documented. An NCM or CA must be initiated, someone is assigned to investigate the issue, and the event is investigated for cause. Table 12-1 provides some general guidelines on determining responsibility for assessment. SOP NC-QA-029, Nonconformance and Corrective Action System, establishes procedures for the identification and documentation of nonconformances and corrective actions and the steps taken to investigate and respond as a result of these events.

12.6.2. The root cause analysis step is the key to the process as a long-term corrective action cannot be determined until the root cause is determined.

12.6.3. Root Cause Analysis is a class of problem solving (investigative) methods aimed at identifying the basic or causal factor(s) that underlie variation in performance or the occurrence of a significant failure. The root cause may be buried under seemingly innocuous events, many steps preceding the perceived failure. At first glance, the immediate response is typically directed at a symptom and not the cause. Typically, root cause analysis would be best with three or more incidents to triangulate a weakness.

12.6.4. Systematically analyze and document the Root Causes of the more significant problems that are reported. Identify, track, and implement the corrective actions required to reduce the likelihood of recurrence of significant incidents. Trend the Root Cause data from these incidents to identify root causes that, when corrected, can lead to dramatic improvements in performance by eliminating entire classes of problems.

12.6.5. Identify the one event associated with problem and ask why this event occurred. Brainstorm the root causes of failures; for example, by asking why events occurred or conditions existed; and then why the cause occurred five consecutive times until you get to the root cause. For each of these sub events or causes, ask why it occurred. Repeat the process for the other events associated with the incident.

12.6.6. Root cause analysis does not mean the investigation is over. Look at technique, or other systems outside the normal indicators. Often creative thinking will find root causes that ordinarily would be missed, and continue to plague the laboratory or operation.

12.6.7. If the root cause is not readily obvious, the Group Leader, Technical Director, Lab Director, QA Manager, or designee is consulted. A team may be assigned to investigate and will collaborate on the resolution of the problem.

12.7. Selection and Implementation of Corrective Actions

12.7.1. Where corrective action is needed, the laboratory must identify potential corrective actions. The action(s) most likely to eliminate the problem and

prevent recurrence are selected and implemented. Responsibility for implementation is assigned.

12.7.2. Corrective actions must be, to a degree, appropriate to the magnitude of the problem identified through the cause analysis.

12.7.3. Whatever corrective action is determined to be appropriate, the laboratory must document and implement the changes. The NCM or CAR is used for this documentation. NCMs are tracked in the laboratory LIMS NCM module. Corrective Actions are tracked in the QA department CA tracking workbook.

12.8. Monitoring of the Corrective Actions

12.8.1. The Group Leader or Technical Director and QA Manager is responsible to ensure the corrective action taken was effective.

12.8.2. Ineffective actions are documented and re-evaluated until acceptable resolution is achieved. The Technical Director are accountable to the Laboratory Director to ensure final acceptable resolution is achieved and documented appropriately.

12.8.3. Each corrective action is recorded in the QA corrective action database for tracking to completion.

12.8.4. Each NCM is recorded in TALS and available for tracking purposes and a summary report of all NCMs can be is reviewedevaluate whether an on-going problem may exist by assessing trending.

12.8.5. The QA Manager reviews monthly NCMs for trends. Highlights are included in the QA monthly report (refer to Section 16). If a significant trend develops that adversely affects quality, an audit of the area is performed and corrective action implemented.

12.8.6. Any out-of-control situations that are not addressed acceptably at the laboratory level may be reported to the Corporate Quality Director by the QA Manager, indicating the nature of the out-of-control situation and problems encountered in solving the situation.

12.9. Follow-up Audits

12.9.1. Follow-up audits may be initiated by the QA Manager and must be performed as soon as possible when the identification of a nonconformance casts doubt on the laboratory's compliance with its own policies and procedures, or on its compliance with state or federal requirements.

12.9.2. These audits often follow the implementation of the corrective actions to verify effectiveness. An additional audit would only be necessary when a critical issue or risk to business is discovered. (Also refer to Section 15.2.4, Special Audits.)

12.10. Technical Corrective Actions

12.10.1. In addition to providing acceptance criteria and specific protocols for technical corrective actions in the method SOPs, the laboratory has general procedures to be followed to determine when departures from the documented policies and procedures and quality control have occurred (refer to Section 11 for information regarding the control of non-conforming work). The documentation of these procedures is through the use of an NCM.

12.10.2. Table 12-1 includes examples of general technical corrective actions. For specific criteria and corrective actions, refer to the analytical methods or specific method SOPs.

12.10.3. Table 12-1 provides some general guidelines for identifying the individual(s) responsible for assessing each QC type and initiating corrective action. The table also provides general guidance on how a data set should be treated if associated QC measurements are unacceptable. Specific procedures are included in Method SOPs, Work Instructions, and QA Manual Sections 19 and 20. The QA Manager reviews all corrective actions monthly, at a minimum, and highlights are included in the QA monthly report.

12.10.4. To the extent possible, samples must be reported only if all quality control measures are acceptable. If the deficiency does not impair the usability of the results, data must be reported with an appropriate data qualifier and/or the deficiency must be noted in the case narrative. Where sample results may be impaired, the Project Manager is notified by a written NCM and appropriate corrective action (e.g., re-analysis) is taken and documented.

12.11. Basic Corrections

12.11.1. When mistakes occur in records, each mistake must be crossed-out with a single line [not obliterated (e.g. no White-Out)], and the correct value entered alongside. All such corrections must be initialed (or signed) and dated by the person making the correction. In the case of records stored electronically, the original “uncorrected” file must be maintained intact and a second “corrected” file is created.

12.11.2. This same process applies to adding additional information to a record. All additions made later than the initial must also be initialed (or signed) and dated.

12.11.3. When corrections are due to reasons other than obvious transcription errors, the reason for the corrections (or additions) must also be documented.

Table 12-1: General Corrective Action Procedures

Inorganic Laboratory Quality Control Samples

Analysis	*QC Sample	Method	NPDES (1)	Method	RCRA (SW846) (2)
Alkalinity	Method Blank (MB)	310.1 2320B	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Concentration must be less than the reporting limit Corrective Action: Rerun all samples associated with unacceptable method blank	--	NA
	Laboratory Control Sample (LCS)	310.1 2320B	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Percent recovery must be within laboratory control limits Corrective Action: If not within laboratory control limits, rerun all associated samples	--	NA
	Matrix Spike/Matrix Spike Duplicate (MS/MSD)	310.1 2320B	Total alkalinity: 1 per batch of 20 samples	--	NA
	Duplicate (DU)	310.1 2320B	For carbonate, bicarbonate, hydroxide, alkalinity, and total alkalinity by SM2320B Frequency: 1 per batch of 10 samples Criteria 310.1: ? 20 % RPD(3) Criteria 2320B: ? 25 % RPD(3) Corrective Action: Flag data outside of limit.	--	NA
Ammonia	Method Blank (MB)	350.2 350.3 SM4500 NH3-C and D	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Concentration less than reporting limit Corrective Action: Rerun all samples associated with unacceptable method	--	NA

Analysis	*QC Sample	Method	NPDES (1)	Method	RCRA (SW846) (2)
			blank		
	Laboratory Control Sample (LCS)	350.2 350.3 SM4500 NH3-C and D	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Percent recovery must be within laboratory control limits Corrective Action: If not within control limits, rerun all associated samples	--	NA
	Matrix Spike/Matrix Spike Duplicate (MS/MSD)	350.2 350.3 SM4500 NH3-C and D	Frequency: 1 per 20 samples, minimum of one per batch of samples processed Criteria: Percent recovery must be within laboratory control limits Corrective Action: Flag data outside of limit	--	NA
	Duplicate (DU)	350.2 350.3 SM4500 NH3-C and D	N/A	—	N/A
Ammonia (TKN)	Method Blank (MB)	351.3 SM4500 N-Org C / SM4500NH3-C	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Concentration must be less than the reporting limit Corrective Action: Rerun all samples associated with unacceptable method blank	—	N/A
	Laboratory Control Sample (LCS)	351.3 SM4500 N-Org C / SM4500NH3-C	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Percent recovery must be within laboratory control limits Corrective Action: If not within laboratory control limits, rerun all associated samples	—	N/A
	Matrix Spike/Matrix	351.3	Frequency: 1 per 20 samples, minimum of	—	N/A

Analysis	*QC Sample	Method	NPDES (1)	Method	RCRA (SW846) (2)
	Spike Duplicate (MS/MSD)	SM4500 N-Org C / SM4500NH3-C	one per batch of samples processed Criteria: Must be within laboratory control limits Corrective Action: Flag data outside of limit		
	Duplicate (DU)	351.3 SM4500 N-Org C / SM4500NH3-C	N/A	—	N/A
BOD	Method Blank (MB)	405.1 SM5210B	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Concentration must be less than the reporting limit. Corrective Action: Rerun all samples associated with unacceptable method blank	—	N/A
	Laboratory Control Sample (LCS)	405.1 SM5210B	Frequency: 1 with each batch of samples processed not to exceed 20 samples. Criteria: Percent recovery must be within laboratory control limits. Corrective Action: If not within laboratory control limits, rerun all associated samples	—	N/A
	Matrix Spike/Matrix Spike Duplicate (MS/MSD)	405.1 SM5210B	N/A	—	N/A
	Duplicate (DU)	405.1 SM5210B	N/A	—	N/A
Anions : Bromide Chloride Fluoride Sulfate Nitrate Nitrite Ortho-phos	Method Blank (MB)	300.0 (4)	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Concentration must be less than the reporting limit	9056A	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Concentration

Analysis	*QC Sample	Method	NPDES (1)	Method	RCRA (SW846) (2)
			Corrective Action: Rerun all samples associated with unacceptable method blank		must be less than the reporting limit Corrective Action: Rerun all samples associated with unacceptable method blank
	Laboratory Control Sample (LCS)	300.0 (4)	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Percent recovery must be within laboratory control limits Corrective Action: If not within control limits, rerun all associated samples	9056A	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Percent recovery must be within laboratory control limits Corrective Action: If not within control limits, rerun all associated samples
	Matrix Spike/Matrix Spike Duplicate (MS/MSD)	300.0 (4)	Frequency: 1 per 10 samples, minimum of one per batch of samples processed Criteria: Percent recovery must be within laboratory control limits Corrective Action: Flag data outside of limit	9056A	Frequency: 1 per 10 samples, minimum of one per batch of samples processed Criteria: Percent recovery must be within laboratory control limits Corrective Action: Flag data outside of limit
	Duplicate (DU)	300.0 (4)	N/A	9056A	N/A
COD	Method Blank (MB)	410.4 SM5220D	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Concentration must be less than the reporting limit Corrective Action: Rerun all samples associated with unacceptable method blank.	—	N/A
	Laboratory Control Sample	410.4 SM5220D	Frequency: 1 with each batch of samples processed not to	—	N/A

Analysis	*QC Sample	Method	NPDES (1)	Method	RCRA (SW846) (2)
	(LCS)		exceed 20 samples Criteria: Percent recovery must be within laboratory control limits Corrective Action: If not within laboratory control limits, rerun all associated samples		
	Matrix Spike/Matrix Spike Duplicate (MS/MSD)	410.4 SM5220D	Frequency: 1 per 10 samples, minimum of one per batch of samples processed Criteria: Must be within laboratory control limits Corrective Action: Flag data outside of limit	—	N/A
	Duplicate (DU)	410.4 SM5220D	N/A	—	N/A
Chloride	Method Blank (MB)	325.2 SM4500 Cl-E	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Concentration must be less than the reporting limit Corrective Action: Rerun all samples associated with unacceptable method blank	9251	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Concentration must be less than the reporting limit Corrective Action: Rerun all samples associated with unacceptable method blank
	Laboratory Control Sample (LCS)	325.2 SM4500 Cl-E	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Percent recovery must be within laboratory control limits Corrective Action: If not within control limits, rerun all associated samples	9251	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Percent recovery must be within laboratory control limits Corrective Action: If not within control limits, rerun all associated samples
	Matrix Spike/Matrix Spike	325.2 SM4500 Cl-E	Frequency: 1 per 10 samples, minimum of one per batch of	9251	Frequency: 1 per 10 samples, minimum of one

Analysis	*QC Sample	Method	NPDES (1)	Method	RCRA (SW846) (2)
	Duplicate (MS/MSD)		samples processed Criteria: Percent recovery must be within laboratory Control limits Flag data outside of limit		per batch of samples processed Criteria: Percent recovery must be within laboratory control limits Corrective Action: Flag data outside of limit
	Duplicate (DU)	325.2 SM4500 Cl-E	N/A	9251	N/A
Chlorine, Residual	Method Blank (MB)	330.5 SM4500 Cl-G	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Concentration must be less than the reporting limit Corrective Action: Rerun all samples associated with unacceptable method blank	—	N/A
	Laboratory Control Sample (LCS)	330.5 SM4500 Cl-G	N/A	—	N/A
	Matrix Spike/Matrix Spike Duplicate (MS/MSD)	330.5 SM4500 Cl-G	N/A	—	N/A
	Duplicate (DU)	330.5 SM4500 Cl-G	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: =20 % RPD(3) Corrective Action: Flag data outside of limit.	—	N/A
Chromium (Cr+6)	Method Blank (MB)	3500 Cr-B	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Concentration must be less than the reporting limit Corrective Action: Rerun all samples associated with unacceptable method blank unless the method blank is above	7196A 3060A	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Concentration must be less than the reporting limit Corrective Action: Rerun all samples associated with

Analysis	*QC Sample	Method	NPDES (1)	Method	RCRA (SW846) (2)
			RL, and samples are ND.		unacceptable method blank unless the method blank is above RL, and samples are ND.
	Laboratory Control Sample (LCS)	3500 Cr-B	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Percent recovery must be within laboratory control limits Corrective Action: If not within laboratory control limits, rerun all associated samples	7196A 3060A	Frequency: 1 soluble and 1 insoluble with each batch of solid samples, 1 with each batch of water samples processed not to exceed 20 samples prepped Criteria: percent recovery for water must be within ± 15 % and for solids must be within ? 20% Corrective Action: Rerun all samples associated with unacceptable LCS
	Matrix Spike/Matrix Spike Duplicate (MS/MSD)	3500 Cr-B	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Must be within laboratory QC limits Corrective Action: Flag data outside of limit	7196A 3060A	Frequency: 1 with each batch of water samples processed not to exceed 20 samples Criteria: Advisory limits are 75% - 125% recovery Corrective Action: Flag data associated with unacceptable Matrix Spike *The Method of Standard Addition is used for solid samples in lieu of a Matrix Spike.*
	Duplicate (DU)	3500 Cr-B	N/A	7196A 3060A	N/A
Conductivity, Specific	Method Blank (MB)	120.1 SM2510B	N/A	9050A	N/A
	Laboratory Control Sample (LCS)	120.1 SM2510B	Frequency: 1 with each batch of samples processed not to exceed 20 samples	9050A	Frequency: 1 with each batch of samples processed not to

Analysis	*QC Sample	Method	NPDES (1)	Method	RCRA (SW846) (2)
			Criteria: Percent recovery must be within laboratory control limits Corrective Action: If not within laboratory control limits, rerun all associated samples		exceed 20 samples Criteria: Percent recovery must be within laboratory control limits Corrective Action: If not within laboratory control limits, rerun all associated samples
	Matrix Spike/Matrix Spike Duplicate (MS/MSD)	120.1 SM2510B	N/A	9050A	N/A
	Duplicate (DU)	120.1 SM2510B	Frequency: 1 with each batch of samples processed not to exceed 10 samples Criteria: =20 % RPD(3) Corrective Action: Flag data outside of limit.	9050A	Frequency: 1 with each batch of samples processed not to exceed 10 samples Criteria: =20 % RPD(3) Corrective Action: Flag data outside of limit.
Cyanide (Weak Acid Dissociable)	Method Blank (MB)	SM4500 CN-I	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Concentration must be less than the reporting limit Corrective Action: Rerun all samples associated with unacceptable method blank	—	N/A
	Laboratory Control Sample (LCS)	SM4500 CN-I	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Percent recovery must be within laboratory control limits Corrective Action: If not within laboratory control limits, rerun all associated samples	—	N/A
	Matrix	SM4500 CN-I	Frequency: 1 per 20	—	N/A

Analysis	*QC Sample	Method	NPDES (1)	Method	RCRA (SW846) (2)
	Spike/Matrix Spike Duplicate (MS/MSD)		samples, minimum of one per batch of samples processed Criteria: Percent recovery must be within laboratory control limits Corrective Action: Flag data outside of limit		
	Duplicate (DU)	SM4500 CN-I	N/A	—	N/A
Cyanide (Amenable)	Method Blank (MB)	335.1 SM4500 CN-G	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Concentration must be less than the reporting limit Corrective Action: Rerun all samples associated with unacceptable method blank	9012A 9012B	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Concentration must be less than the reporting limit Corrective Action: Rerun all samples associated with unacceptable method blank
	Laboratory Control Sample (LCS)	335.1 SM4500 CN-G	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Percent recovery must be within laboratory control limits Corrective Action: If not within laboratory control limits, rerun all associated samples	9012A 9012B	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Percent recovery must be within laboratory control limits Corrective Action: If not within laboratory control limits, rerun all associated samples
	Matrix Spike/Matrix Spike Duplicate (MS/MSD)	335.1 SM4500 CN-G	Frequency: 1 per 20 samples, minimum of one per batch of samples processed Criteria: Percent recovery must be within laboratory control limits Corrective Action: Flag data outside of limit	9012A 9012B	Frequency: 1 per 20 samples, minimum of one per batch of samples processed Criteria: Percent recovery must be within laboratory control limits Corrective Action:

Analysis	*QC Sample	Method	NPDES (1)	Method	RCRA (SW846) (2)
					Flag data outside of limit
	Duplicate (DU)	335.1 SM4500 CN-G	N/A	9012A 9012B	N/A
Cyanide (Total)	Method Blank (MB)	335.2 335.4 SM4500 CN-E 335.2-CLP-M (Ohio VAP)	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Concentration must be less than the reporting limit Corrective Action: Rerun all samples associated with unacceptable method blank unless the method blank is above RL, and samples are ND.	9012A 9012B	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Concentration must be less than the reporting limit Corrective Action: Rerun all samples associated with unacceptable method blank unless the method blank is above RL, and samples are ND.
	Laboratory Control Sample (LCS)	335.2 335.4 SM4500 CN-E 335.2-CLP-M (Ohio VAP)	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Percent recovery must be within laboratory control limits Corrective Action: If not within laboratory control limits, rerun all associated samples	9012A 9012B	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Percent recovery must be within laboratory control limits Corrective Action: If not within laboratory control limits, rerun all associated samples
	Matrix Spike/Matrix Spike Duplicate (MS/MSD)	335.2 335.4 SM4500 CN-E 335.2-CLP-M (Ohio VAP)	Frequency: 1 per 20 samples, minimum of one per batch of samples processed Criteria: Percent recovery must be within laboratory control limits Corrective Action: Flag data outside of limit	9012A 9012B	Frequency: 1 per 20 samples, minimum of one per batch of samples processed Criteria: Percent recovery must be within laboratory control limits Corrective Action: Flag data outside of limit

Analysis	*QC Sample	Method	NPDES (1)	Method	RCRA (SW846) (2)
	Duplicate (DU)	335.2 335.4 SM4500 CN-E 335.2-CLP-M (Ohio VAP)	N/A	9012A 9012B	N/A
Dissolve Oxygen (DO)	Method Blank (MB)	360.1 SM4500 O-G	N/A	—	N/A
	Laboratory Control Sample (LCS)	360.1 SM4500 O-G	N/A	—	N/A
	Matrix Spike/Matrix Spike Duplicate (MS/MSD)	360.1 SM4500 O-G	N/A	—	N/A
	Duplicate (DU)	360.1 SM4500 O-G	N/A	—	N/A
Flashpoint	Method Blank (MB)		N/A	1010 1010A	N/A
	Laboratory Control Sample (LCS)		N/A	1010 1010A	N/A
	Matrix Spike/Matrix Spike Duplicate (MS/MSD)		N/A	1010 1010A	N/A
	Duplicate (DU)		Frequency: 1 per 20 samples per matrix, minimum of one per batch of samples processed Criteria: Percent recovery must be within laboratory control limits Corrective Action: Flag data outside of limit	1010 1010A	Frequency: 1 per 20 samples per matrix, minimum of one per batch of samples processed Criteria: Percent recovery must be within laboratory control limits Corrective Action: Flag data outside of limit
Fluoride (ISE)	Method Blank (MB)	340.2 SM4500 F-C	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Concentration must be less than the reporting limit Corrective Action: Rerun all samples associated with	—	N/A

Analysis	*QC Sample	Method	NPDES (1)	Method	RCRA (SW846) (2)
			unacceptable method blank		
	Laboratory Control Sample (LCS)	340.2 SM4500 F-C	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Percent recovery must be within laboratory control limits Corrective Action: If not within laboratory control limits, rerun all associated samples	—	N/A
	Matrix Spike/Matrix Spike Duplicate (MS/MSD)	340.2 SM4500 F-C	Frequency: 1 per 20 samples by Criteria: Must be within laboratory QC limits Corrective Action: Flag data outside of limit	—	N/A
	Duplicate (DU)	340.2 SM4500 F-C	N/A	—	N/A
Hardness	Method Blank (MB)	130.2 SM2340B SM2340C	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Concentration must be less than the reporting limit Corrective Action: Rerun all samples associated with unacceptable method blank	—	N/A
	Laboratory Control Sample (LCS)	130.2 SM2340B SM2340C	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Percent recovery must be within laboratory control limits Corrective Action: If not within laboratory control limits, rerun all associated samples	—	N/A
	Matrix Spike/Matrix Spike Duplicate (MS/MSD)	130.2 SM2340B SM2340C	Method 130.2: 1 per 20 samples Method 2340B: Frequency, Criteria, and Corrective Action: See ICP Metals Method 200.7	—	N/A

Analysis	*QC Sample	Method	NPDES (1)	Method	RCRA (SW846) (2)
			Requirements		
	Duplicate (DU)	130.2 SM2340B SM2340C	Frequency: One with every 10 samples.	—	N/A
Iron (Ferrous and Ferric)	Method Blank (MB)	SM3500 Fe-B	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Concentration must be less than the reporting limit Corrective Action: Rerun all samples associated with unacceptable method blank	—	N/A
	Laboratory Control Sample (LCS)	SM3500 Fe-B	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Percent recovery must be within laboratory control limits Corrective Action: If not within laboratory control limits, rerun all associated samples	—	N/A
	Matrix Spike/Matrix Spike Duplicate (MS/MSD)	SM3500 Fe-B	Frequency: 1 every 20 samples Criteria: Must be within laboratory QC limits Corrective Action: Flag associated data outside of limit	—	N/A
	Duplicate (DU)	SM3500 Fe-B	N/A	—	N/A
Paint Filter	Method Blank (MB)	—	N/A	9095A 9095B	N/A
	Laboratory Control Sample (LCS)	—	N/A	9095A 9095B	N/A
	Matrix Spike/Matrix Spike Duplicate (MS/MSD)	—	N/A	9095A 9095B	N/A
	Duplicate (DU)	—	N/A	9095A 9095B	Frequency: Two per batch of 20 samples.
pH	Method Blank (MB)	150.1 SM4500 H+B	N/A	9040B 9040C	N/A

Analysis	*QC Sample	Method	NPDES (1)	Method	RCRA (SW846) (2)
				9045C 9045D 9041	
	Laboratory Control Sample (LCS)	150.1 SM4500 H+B	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Percent recovery must be within laboratory control limits Corrective Action: If not within laboratory control limits, rerun all associated samples	9040B 9040C 9045C 9045D 9041	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Percent recovery must be within laboratory control limits Corrective Action: If not within laboratory control limits, rerun all associated samples
	Matrix Spike/Matrix Spike Duplicate (MS/MSD)	150.1 SM4500 H+B	N/A	9040B 9040C 9045C 9045D 9041	N/A
	Duplicate (DU)	150.1 SM4500 H+B	Frequency: 1 with each batch of samples processed not to exceed 10 samples per matrix Criteria: =20 % RPD(3) limit Corrective Action: Flag data outside of limit.	9040B 9040C 9045C 9045D 9041	Frequency: 1 with each batch of samples processed not to exceed 10 samples per matrix Criteria: = 20 % RPD(3) limit Corrective Action: Flag data outside of limit.
Phenolics	Method Blank (MB)	420.1	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Concentration must be less than the reporting limit Corrective Action: Rerun all samples associated with unacceptable method blank	9065	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Concentration must be less than the reporting limit Corrective Action: Rerun all samples associated with unacceptable method blank
	Laboratory Control	420.1	Frequency: 1 with each batch of samples	9065	Frequency: 1 with each batch of

Analysis	*QC Sample	Method	NPDES (1)	Method	RCRA (SW846) (2)
	Sample (LCS)		processed not to exceed 20 samples Criteria: Percent recovery must be within laboratory control limits Corrective Action: If not within laboratory control limits, rerun all associated samples		samples processed not to exceed 20 samples Criteria: Percent recovery must be within laboratory control limits Corrective Action: If not within laboratory control limits, rerun all associated samples
	Matrix Spike/Matrix Spike Duplicate (MS/MSD)	420.1	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Percent recovery must be within laboratory control limits Corrective Action: Flag data associated with unacceptable matrix spike	9065	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Percent recovery must be within laboratory control limits Corrective Action: Flag data associated with unacceptable matrix spike
	Duplicate (DU)	420.1	N/A	9065	N/A
Phosphorus (Total and Ortho)	Method Blank (MB)	365.1 SM4500 P-E	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Concentration must be less than the reporting limit Corrective Action: Rerun all samples associated with unacceptable method blank	—	N/A
	Laboratory Control Sample (LCS)	365.1 SM4500 P-E	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Percent recovery must be within laboratory control limits Corrective Action: If not within laboratory	—	N/A

Analysis	*QC Sample	Method	NPDES (1)	Method	RCRA (SW846) (2)
			control limits, rerun all associated samples		
	Matrix Spike/Matrix Spike Duplicate (MS/MSD)	365.1 SM4500 P-E	Frequency: 1 per 20 samples Criteria: Must be within laboratory QC limits Corrective Action: Flag data outside of limit	—	N/A
	Duplicate (DU)	365.1 SM4500 P-E	N/A	—	N/A
Solids in Water	Method Blank (MB)	160.1 160.2 160.3 SM2540B SM2540C SM2540D	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Concentration must be less than the reporting limit Corrective Action: If analyte level in method blank is ±RL for the analyte of interest in the sample, all associated samples with reportable levels of analyte are re-prepared and re-analyzed.	—	N/A
	Laboratory Control Sample (LCS)	160.1 160.2 160.3 SM2540B SM2540C SM2540D	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Percent recovery must be within laboratory control limits Corrective Action: If not within laboratory control limits, re-prepare and rerun all associated samples	—	N/A
	Matrix Spike/Matrix Spike Duplicate (MS/MSD)	160.1 160.2 160.3 SM2540B SM2540C SM2540D	N/A	—	N/A
	Duplicate (DU)	160.1 160.2 160.3 SM2540B SM2540C SM2540D	Frequency: 1 with each batch of samples processed not to exceed 10 samples Criteria: Sample results should agree within 20%.	—	N/A

Analysis	*QC Sample	Method	NPDES (1)	Method	RCRA (SW846) (2)
Solids (Settleable)	Method Blank (MB)	160.5 SM2540F	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Concentration must be less than the reporting limit Corrective Action: If analyte level in method blank is ±RL for the analyte of interest in the sample, all associated samples with reportable levels of analyte are re-prepared and re-analyzed.	—	N/A
	Laboratory Control Sample (LCS)	160.5 SM2540F	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Percent recovery must be within laboratory control limits Corrective Action: If not within laboratory control limits, re-prepare and rerun all associated samples	—	N/A
	Matrix Spike/Matrix Spike Duplicate (MS/MSD)	160.5 SM2540F	N/A	—	N/A
	Duplicate (DU)	160.5 SM2540F	N/A	—	N/A
Solids (Percent Moisture)	Method Blank (MB)	160.3 (mod)	N/A	—	N/A
	Laboratory Control Sample (LCS)	160.3 (mod)	N/A	—	N/A
	Matrix Spike/Matrix Spike Duplicate (MS/MSD)	160.3 (mod)	N/A	—	N/A
	Duplicate (DU)	160.3 (mod)	Frequency: 1 with each batch of samples processed not to exceed 10 samples Criteria: Sample results	—	N/A

Analysis	*QC Sample	Method	NPDES (1)	Method	RCRA (SW846) (2)
			should agree within 20%.		
Sulfate (Turbidimetric)	Method Blank (MB)	375.4	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Concentration must be less than the reporting limit Corrective Action: Rerun all samples associated with unacceptable method blank	9038	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Concentration must be less than the reporting limit Corrective Action: Rerun all samples associated with unacceptable method blank
	Laboratory Control Sample (LCS)	375.4	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Percent recovery must be within laboratory control limits Corrective Action: If not within laboratory control limits, rerun all associated samples	9038	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Percent recovery must be within ± 15 % Corrective Action: If not within laboratory control limits, rerun all associated samples
	Matrix Spike/Matrix Spike Duplicate (MS/MSD)	375.4	Frequency: 1 per 10 samples, minimum of one per batch of samples processed Criteria: Percent recovery must be within laboratory control limits Corrective Action: Flag data outside of limit	9038	Frequency: 1 with each batch of samples processed not to exceed 10 samples Criteria: Limits are 75% - 125% recovery Corrective Action: Flag data associated with unacceptable Matrix Spike
	Duplicate (DU)	375.4	N/A	9038	N/A
Sulfide	Method Blank (MB)	376.1 SM4500 S2-F	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Concentration	9030B 9034	Frequency: 1 with each batch of samples processed not to exceed 20

Analysis	*QC Sample	Method	NPDES (1)	Method	RCRA (SW846) (2)
			must be less than the reporting limit Corrective Action: Rerun all samples associated with unacceptable method blank		samples Criteria: Concentration must be less than the reporting limit Corrective Action: Rerun all samples associated with unacceptable method blank
	Laboratory Control Sample (LCS)	376.1 SM4500 S2-F	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Percent recovery must be within laboratory control limits Corrective Action: If not within laboratory control limits, rerun all associated samples	9030B 9034	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Percent recovery must be within laboratory control limits Corrective Action: If not within laboratory control limits, rerun all associated samples
	Matrix Spike/Matrix Spike Duplicate (MS/MSD)	376.1 SM4500 S2-F	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Percent recovery must be within laboratory control limits Corrective Action: Flag data outside of limit	9030B 9034	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Percent recovery must be within laboratory control limits Corrective Action: Flag data outside of limit
	Duplicate (DU)	376.1 SM4500 S2-F	N/A	9030B 9034	N/A
Total Organic Carbon (TOC)	Method Blank (MB)	415.1 SM5310C	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Concentration must be less than the reporting limit Corrective Action: Rerun all samples associated with unacceptable method	9060 9060A Walkley Black	Frequency: 1 with each batch of samples processed not to exceed 20 samples. Criteria: Concentration less than reporting limit Corrective Action: Rerun all samples

Analysis	*QC Sample	Method	NPDES (1)	Method	RCRA (SW846) (2)
			blank		associated with unacceptable method blank
	Laboratory Control Sample (LCS)	415.1 SM5310C	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Percent recovery must be within laboratory control limits Corrective Action: If not within laboratory control limits, rerun all associated samples	9060 9060A Walkley Black	Frequency: 1 with each batch of samples processed not to exceed 20 samples Method 9060 requires and LCS every 15 samples. Criteria: percent recovery must be within laboratory control limits Corrective Action: Rerun all samples associated with unacceptable LCS
	Matrix Spike/Matrix Spike Duplicate (MS/MSD)	415.1 SM5310C	Frequency: 1 per 20 samples, minimum of one per batch of samples processed Criteria: Percent recovery must be within laboratory control limits Corrective Action: Flag data outside of limit	9060 9060A Walkley Black	Frequency: (Water matrix only) 1 with each batch of samples processed not to exceed 20 samples. Method 9060 requires a matrix spike every 10 samples. Criteria: Percent recovery must be within laboratory control limits Corrective Action: Reanalyze if sample remaining. If not, flag data associated with unacceptable Matrix Spike
	Duplicate (DU)	415.1 SM5310C	N/A	9060 9060A Walkley Black	Frequency: (Solid matrix only) One for every 10 samples. Criteria: = 20% RPD between sample results. Corrective Action: Flag data with unacceptable RPD
Turbidity	Method Blank	180.1	Frequency: 1 with each	—	N/A

Analysis	*QC Sample	Method	NPDES (1)	Method	RCRA (SW846) (2)
	(MB)		batch of samples processed not to exceed 20 samples Criteria: Concentration must be less than the reporting limit Corrective Action: Rerun all samples associated with unacceptable method blank		
	Laboratory Control Sample (LCS)	180.1	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Percent recovery must be within laboratory control limits Corrective Action: If not within laboratory control limits, rerun all associated samples	—	N/A
	Matrix Spike/Matrix Spike Duplicate (MS/MSD)	180.1	N/A	—	N/A
	Duplicate (DU)	180.1	Frequency: 1 per 10 samples Criteria: Must be within laboratory QC limits Corrective Action: Flag data outside of limit	—	N/A
Specific Gravity	Method Blank (MB)	SM2710 F	N/A	—	N/A
	Laboratory Control Sample (LCS)	SM2710 F	N/A	—	N/A
	Matrix Spike/Matrix Spike Duplicate (MS/MSD)	SM2710 F	N/A	—	N/A
	Duplicate (DU)	SM2710 F	Frequency: 1 per 20 samples Criteria: Must be within laboratory QC limits Corrective Action: Flag data outside of limit	—	N/A
Mercury by CVAA &	Method Blank (MB)	245.1 1631E	Frequency: 1 with each batch of samples	7470A 7471A	Frequency: 1 with each batch of

Analysis	*QC Sample	Method	NPDES (1)	Method	RCRA (SW846) (2)
CVAF			processed not to exceed 20 samples Criteria: Concentration less than reporting limit Corrective Action: Rerun all samples associated with unacceptable method blank, unless the method blank is above RL, and samples are ND.	7471B	samples processed not to exceed 20 samples Criteria: Concentration less than reporting limit Corrective Action: Rerun all samples associated with unacceptable method blank, unless the method blank is above RL, and samples are ND.
	Laboratory Control Sample (LCS)	245.1 1631E	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: For 245.1 percent recovery of analyte must be within ± 20 %. For 1631E the percent recovery is +/- 23% Corrective Action: Rerun all samples associated with unacceptable LCS, unless samples are ND, results are reported.	7470A 7471A 7471B	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: percent recovery of analyte must be within ± 20 % Corrective Action: Rerun all samples associated with unacceptable LCS samples are ND, results are reported. . Exception: If samples are ND, results are reported.
	Matrix Spike/Matrix Spike Duplicate (MS/MSD)	245.1 1631E	Frequency: with each batch of samples processed not to exceed 20 samples. 1631E frequency is 1 in 10 samples, 71-125% Criteria: For Method 245.1 recovery should be within 70-130 % Corrective Action: Flag data associated with unacceptable MS.	7470A 7471A 7471B	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: For Method 7470A, recovery should be within 75-125 %. For Methods 7471A and 7471B, a criterion is 70-130%. Corrective Action:

Analysis	*QC Sample	Method	NPDES (1)	Method	RCRA (SW846) (2)
					Flag data associated with unacceptable MS.
	Duplicate (DU)	245.1 1631E	N/A	7470A 7471A 7471B	N/A
Metals (ICP and ICP/MS)	Method Blank (MB)	200.7 200.8	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Concentration less than reporting limit. Concentration less than reporting with the exception of lab common contaminants. Sample results <RL are also valid. Corrective Action: Rerun all samples associated with unacceptable method blank unless the method blank is above RL, and samples are ND.	6010B 6010C 6020 6020A	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Concentration less than reporting limit. Concentration less than reporting with the exception of lab common contaminants. Sample results <RL are also valid. Corrective Action: Rerun all samples associated with unacceptable method blank unless the method blank is above RL, and samples are ND.
	Laboratory Control Sample (LCS)	200.7 200.8	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: percent recovery of analyte must be ± 85-115%. If LCS is biased high and samples are <RL, the results are valid. Corrective Action: Rerun all samples associated with unacceptable LCS If samples are ND, results are reported.	6010B 6010C 6020 6020A	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: percent recovery of analyte must be ± 20 %. If LCS is biased high and samples are <RL, the results are valid. Corrective Action: Rerun all samples associated with unacceptable LCS If samples are ND, results are

Analysis	*QC Sample	Method	NPDES (1)	Method	RCRA (SW846) (2)
					reported.
	Matrix Spike/Matrix Spike Duplicate (MS/MSD)	200.7 200.8	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Limits for percent recovery are 70-130%, RPD(3) must be within 20% Corrective Action: Flag data associated with unacceptable matrix spike	6010B 6010C 6020 6020A	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Limits for percent recovery must be within laboratory limits. RPD(3) must be within 20% Corrective Action: Flag data associated with unacceptable matrix spike
	Duplicate (DU)	200.7 200.8	N/A	6010B 6010C 6020 6020A	N/A
	Serial Dilution (SD)	200.7 200.8	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: 10% difference. 10% difference only applied if sample results are >50 times MDL. Corrective Action: Flag data associated with unacceptable serial dilution	6010B 6010C 6020 6020A	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: 10% difference. 10% difference only applied if sample results are >50 times MDL. Corrective Action: Flag data associated with unacceptable serial dilution
	Post Digestion Spike (PDS)	200.7 200.8	Frequency: When dilution test fails to meet criteria. Criteria: Recovery must be within 75 – 125%. Corrective Action: Flag results for matrix interference.	6010B 6010C 6020 6020A	Frequency: When dilution test fails to meet criteria. Criteria: Recovery must be within 75 – 125%. Corrective Action: Flag results for matrix interference.

Footnotes
1. *National Pollutant Discharge Elimination System*

2. *Resource Conservation and Recovery Act, Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, (SW-846), Third Edition, September 1986. Contains Final Update I (July 1992), Final Update IIA (August 1993), Final Update II (September 1994), Final Update IIB (January 1995), and Final Update III (December 1996), Update IV (2007).*
3. *RPD-Relative Percent Difference*
4. *Method not listed in 40 CFR Part 136. Method 300.0 is a proposed 40CFR method. Specific state and/or region approval is required for NPDES.*

Organic Laboratory Quality Control Samples

Analysis	*QC Sample	Method	NPDES 1	Method	RCRA (SW846) 2
Herbicides	Method Blank (MB)	--	NA	8151A	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Concentration must be less than the reporting limit Corrective Action: Rerun all samples associated with unacceptable method blank
	Laboratory Control Sample (LCS)	--	NA	8151A	Frequency: 1 with each extraction batch of samples not to exceed 20 samples Criteria: Percent recovery for each analyte must be within laboratory control limits Corrective Action: Re-extract and reanalyze all samples associated with unacceptable LCS
	Matrix Spike/Matrix Spike Duplicate (MS/MSD)	--	NA	8151A	Frequency: 1 with each extraction batch of samples not to exceed 20 samples Criteria: percent recovery for each analyte should be within laboratory

Analysis	*QC Sample	Method	NPDES 1	Method	RCRA (SW846) 2
					control limits Corrective Action: Flag data associated with unacceptable matrix spike sample
	Duplicate (DU)	--	NA	8151A	N/A
	Surrogates (Surr)	--	NA	8151A	Surrogates spiked into method blank and all samples (QC included) Method Blank Criteria and LCS: All surrogates must fall within laboratory established control limits before sample analysis may proceed. Sample Criteria: Re-extract and reanalyze samples or flag sample data not meeting surrogate criteria
	Internal Standards (IS)	--	NA	8151A	Optional
Pesticides and PCBs	Method Blank (MB)	608	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Concentration less than reporting limit Corrective Action: Rerun all samples associated with unacceptable method blank	8081A 8081B 8082 8082A	Frequency: 1 with each extraction batch of samples not to exceed 20 samples Criteria: Concentration less than reporting limit Corrective Action: Re-prepare and reanalyze all samples associated with unacceptable method blank
	Laboratory Control Sample (LCS)	608	Frequency: 1 with each extraction batch of samples not to exceed 20 samples Criteria: percent recovery must be within control limits given in method for each analyte	8081A 8081B 8082 8082A	Frequency: 1 with each extraction batch of samples not to exceed 20 samples Criteria: percent recovery must be within control limits given in method for each analyte Corrective Action:

Analysis	*QC Sample	Method	NPDES 1	Method	RCRA (SW846) 2
			Corrective Action: Rerun all samples associated with unacceptable LCS		Rerun all samples associated with unacceptable LCS
	Matrix Spike/Matrix Spike Duplicate (MS/MSD)	608	Frequency: 1 per 10 samples from each site or 1 per month, whichever is more frequent Criteria: percent recovery for each analyte should be within advisory limits given in method Corrective Action: Flag data associated with unacceptable Matrix Spike	8081A 8081B 8082 8082A	Frequency: 1 per 10 samples from each site or 1 per month, whichever is more frequent Criteria: percent recovery for each analyte should be within advisory limits given in method Corrective Action: Flag data associated with unacceptable Matrix Spike
	Duplicate (DU)	608	N/A	8081A 8081B 8082 8082A	N/A
	Surrogates (Surr)	608	Frequency: Surrogates spiked into method blank and all samples (QC included) Method Blank Criteria and LCS: Results must fall within laboratory established control limits Sample Criteria: Re-extract and reanalyze samples or flag sample data not meeting surrogate criteria	8081A 8081B 8082 8082A	Frequency: Surrogates spiked into method blank and all samples (QC included) Method Blank Criteria and LCS: Results must fall within laboratory established control limits Sample Criteria: Re-extract and reanalyze samples or flag sample data not meeting surrogate criteria
Petroleum Hydrocarbons (Inorganics: HEM/SGT HEM)	Method Blank (MB)	1664A	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Concentration must be less than the reporting limit Corrective Action: Rerun all samples	—	N/A

Analysis	*QC Sample	Method	NPDES 1	Method	RCRA (SW846) 2
			associated with unacceptable method blank		
	Laboratory Control Sample (LCS)	1664A	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Percent recovery is specified by the method. 78-114%, 11% RPD for HEM and 64-132%, 28% RPD for SGT HEM. Corrective Action: If not within laboratory control limits, rerun all associated samples	—	N/A
	Matrix Spike/Matrix Spike Duplicate (MS/MSD)	1664A	Frequency: 1 with every 10 samples per site Criteria: Percent recovery is specified by the method, 78-114%, 11% RPD for HEM and 64-132%, 28% RPD for SGT HEM Corrective Action: Flag data associated with unacceptable Matrix Spike	—	N/A
	Duplicate (DU)	1664A	N/A	—	N/A
Semivolatiles	Method Blank (MB)	625	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Concentration must be less than the reporting limit. Corrective Action: Rerun all samples associated with unacceptable	8270C 8270D	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Concentration must be less than the reporting limit. Corrective Action: Rerun all samples associated with unacceptable

Analysis	*QC Sample	Method	NPDES 1	Method	RCRA (SW846) 2
			method blank		method blank
	Laboratory Control Sample (LCS)	625	Frequency: 1 with each batch of samples processed not to exceed 20 samples. Criteria: Percent recovery must be within laboratory control limits. Corrective Action: If not within laboratory control limits, rerun all associated samples	8270C 8270D	Frequency: 1 with each batch of samples processed not to exceed 20 samples. Criteria: Percent recovery must be within laboratory control limits. Corrective Action: If not within laboratory control limits, rerun all associated samples
	Matrix Spike/Matrix Spike Duplicate (MS/MSD)	625	Frequency: 1 with each extraction batch of samples not to exceed 20 samples Criteria: percent recovery for each analyte should be within advisory limits given in method Corrective Action: Flag data associated with unacceptable Matrix Spike	8270C 8270D	Frequency: 1 with each extraction batch of samples not to exceed 20 samples Criteria: percent recovery for each analyte should be within advisory limits given in method Corrective Action: Flag data associated with unacceptable Matrix Spike
	Duplicate (DU)	625	N/A	8270C 8270D	N/A
	Surrogates (Surr)	625	Frequency: Surrogates spiked into method blank and all samples (QC included) Method Blank and LCS Criteria: All surrogates must be in control before sample analysis may proceed. One surrogate per fraction may exceed control limits if greater than 10% recovery. Sample Criteria:	8270C 8270D	Frequency: Surrogates spiked into method blank and all samples (QC included) Method Blank and LCS Criteria: All surrogates must be in control before sample analysis may proceed. One surrogate per fraction may exceed control limits if greater than 10% recovery. Sample Criteria: Re-extract samples or flag sample data not

Analysis	*QC Sample	Method	NPDES 1	Method	RCRA (SW846) 2
			Re-extract samples or flag sample data not meeting surrogate criteria		meeting surrogate criteria
	Internal Standards (IS)	625	Frequency: Internal standards spiked into method blank and all samples (QC included) Criteria: All internal standard recoveries must be within laboratory control limits Corrective Action: Flag sample data not meeting internal standard recovery requirements	8270C 8270D	Frequency: Internal Standards are added to all samples (QC samples included). Criteria: area of daily standard must be within 50% to 200% of the response in the mid-level of the initial calibration standard. The retention time (RT) for any internal standard (IS) in the continuing calibration must not exceed ± 0.5 minutes from mid-level initial calibration standard IS RT.
Volatiles by GC/MS	Method Blank (MB)	624	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Concentration must be less than the reporting limit Corrective Action: Rerun all samples associated with unacceptable method blank	8260A 8260B 8260C	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Concentration must be less than the reporting limit Corrective Action: Rerun all samples associated with unacceptable method blank
	Laboratory Control Sample (LCS)	624	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Percent recovery must be within laboratory control limits Corrective Action: If not within control limits, rerun all	8260A 8260B 8260C	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Percent recovery must be within laboratory control limits Corrective Action: If not within control limits, rerun all associated samples

Analysis	*QC Sample	Method	NPDES 1	Method	RCRA (SW846) 2
			associated samples		
	Matrix Spike/Matrix Spike Duplicate (MS/MSD)	624	Frequency: 1 per 20 samples, minimum of one per batch of samples processed Criteria: Percent recovery must be within laboratory control limits Corrective Action: Flag data outside of limit	8260A 8260B 8260C	Frequency: 1 per 20 samples, minimum of one per batch of samples processed Criteria: Percent recovery must be within laboratory control limits Corrective Action: Flag data outside of limit
	Duplicate (DU)	624	N/A	8260A 8260B 8260C	N/A
	Surrogates (Surr)	624	Frequency: Surrogates are spiked into all samples (including all QC samples) Criteria: All surrogates must meet criteria Corrective Action: Re-extract and re-analyze samples or flag sample data not meeting surrogate criteria.	8260A 8260B 8260C	Frequency: Surrogates are spiked into all samples (including all QC samples) Criteria: All surrogates must meet criteria Corrective Action: Re-extract and re-analyze samples or flag sample data not meeting surrogate criteria.
	Internal Standards (IS)	624	Frequency: Internal standards spiked into method blank and all samples (QC included) Criteria: All internal standard recoveries must be within laboratory control limits Corrective Action: Flag sample data not meeting internal standard recovery requirements	8260A 8260B 8260C	Frequency: Internal standards spiked into method blank and all samples (QC included) Criteria: All internal standard recoveries must be within laboratory control limits Corrective Action: Flag sample data not meeting internal standard recovery requirements
Methyl Mercury	Method Blank (MB)	1630	Frequency: 1 with each batch of samples	—	N/A

Analysis	*QC Sample	Method	NPDES 1	Method	RCRA (SW846) 2
			processed not to exceed 20 samples Criteria: Concentration must be less than the reporting limit Corrective Action: Rerun all samples associated with unacceptable method blank.		
	Laboratory Control Sample (LCS)	1630	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Percent recovery must be within laboratory control limits Corrective Action: If not within laboratory control limits, rerun all associated samples	—	N/A
	Matrix Spike/Matrix Spike Duplicate (MS/MSD)	1630	Frequency: 1 per 10 samples, minimum of one per batch of samples processed Criteria: Must be within laboratory control limits Corrective Action: Flag data outside of limit	—	N/A
	Duplicate (DU)	1630	N/A	—	N/A
	Surrogates (Surr)	1630	Frequency: Surrogates are spiked into all samples (including all QC samples) Criteria: All surrogates must meet criteria Corrective Action: Re-extract and re-analyze samples	—	N/A

Analysis	*QC Sample	Method	NPDES 1	Method	RCRA (SW846) 2
			or flag sample data not meeting surrogate criteria.		
Formaldehyde	Method Blank (MB)	—	N/A	8315A	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Concentration must be less than the reporting limit Corrective Action: Rerun all samples associated with unacceptable method blank
	Laboratory Control Sample (LCS)	—	N/A	8315A	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Percent recovery must be within laboratory control limits Corrective Action: If not within control limits, rerun all associated samples
	Matrix Spike/Matrix Spike Duplicate (MS/MSD)	—	N/A	8315A	Frequency: 1 per 10 samples, minimum of one per batch of samples processed Criteria: Percent recovery must be within laboratory control limits Corrective Action: Flag data outside of limit
	Duplicate (DU)	—	N/A	8315A	N/A
Diesel Range Organics (DRO) and Gasoline Range Organics (GRO)	Method Blank (MB)	—	N/A	8015B 8015C 8015D	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Concentration must be less than the reporting limit Corrective Action: Rerun all samples

Analysis	*QC Sample	Method	NPDES 1	Method	RCRA (SW846) 2
					associated with unacceptable method blank
	Laboratory Control Sample (LCS)	—	N/A	8015B 8015C 8015D	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Percent recovery should be within advisory limits given in the method. Corrective Action: Rerun all samples associated with unacceptable LCS
	Matrix Spike/Matrix Spike Duplicate (MS/MSD)	—	N/A	8015B 8015C 8015D	Frequency: 1 per 20 samples. Criteria: percent recovery for each analyte should be within laboratory limits. Corrective Action: Flag data associated with unacceptable Matrix Spike
	Surrogates (Surr)	—	N/A	8015B 8015C 8015D	Frequency: Surrogates are spiked into all samples (including all QC samples) Criteria: All surrogates must meet criteria Corrective Action: Re-extract and re-analyze samples or flag sample data not meeting surrogate criteria.
Aromatic Acids	Method Blank (MB)	—	N/A	Client Derived	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Concentration must be less than the reporting limit Corrective Action: Rerun all samples associated with unacceptable

Analysis	*QC Sample	Method	NPDES 1	Method	RCRA (SW846) 2
					method blank unless the method blank is above RL, and samples are ND.
	Laboratory Control Sample (LCS)	—	N/A	Client Derived	Frequency: 1 soluble and 1 insoluble with each batch of solid samples, 1 with each batch of water samples processed not to exceed 20 samples prepped Criteria: Percent recovery for analytes should be within laboratory accepted limits Corrective Action: Rerun all samples associated with unacceptable LCS
	Matrix Spike/Matrix Spike Duplicate (MS/MSD)	—	N/A	Client Derived	Frequency: 1 with each batch of water samples processed not to exceed 20 samples Criteria: Percent recovery for analytes should be within laboratory accepted limits Corrective Action: Flag data associated with unacceptable Matrix Spike
	Duplicate (DU)	--	N/A	Client Derived	N/A

* For the Ohio EPA Voluntary Action Program (VAP), please refer to the SOPs for the acceptable criteria, corrective actions, and exceptions.

Footnotes

1. *National Pollutant Discharge Elimination System*
2. *Resource Conservation and Recovery Act, Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, (SW-846), Third Edition, September 1986. Contains Final Update I (July 1992), Final Update IIA (August 1993), Final Update II (September 1994), Final Update IIB (January 1995), Final Update III (December 1996), and Final Update IV (2007)*

13. PREVENTIVE ACTION / IMPROVEMENT

13.1. OVERVIEW

13.1.1. The laboratory's preventive action programs improve or eliminate potential causes of nonconforming product and/or nonconformance to the quality system. This preventive action process is a proactive and continuous process of improvement activities that can be initiated through feedback from clients, employees, business providers, and affiliates. The QA Department has the overall responsibility to ensure the preventive action process is in place, and that relevant information on actions is submitted for management review.

13.1.2. Dedicating resources to an effective preventive action system emphasizes the laboratory's commitment to its Quality Program. It is beneficial to identify and address negative trends before they develop into complaints, problems and corrective actions. Additionally, customer service and client satisfaction can be improved through continuous improvements to laboratory systems.

13.1.3. Opportunities for improvement may be discovered during management reviews, the monthly QA Metrics Report, evaluation of internal or external audits, results and evaluation of proficiency testing (PT) performance, data analysis and review processing operations, client complaints, staff observation, etc.

13.1.4. The monthly Management Systems Metrics Report shows performance indicators in all areas of the laboratory and quality system. These areas include revised reports, corrective actions, audit findings, internal auditing and data authenticity audits, client complaints, PT samples, holding time violations, SOPs, Ethics training, etc. These metrics are used in evaluating the management and quality system performance on an ongoing basis and provide a tool for identifying areas for improvement.

13.1.5. The laboratory's corrective action process (Section 12) is integral to implementation of preventive actions. A critical piece of the corrective action process is the implementation of actions to prevent further occurrence of a non-compliance event. Historical review of corrective action provides a valuable mechanism for identifying preventive action opportunities.

13.1.6. The following elements are part of a preventive action system:

13.1.6.1. Identification of an opportunity for preventive action.

13.1.6.2. Process for the preventive action.

13.1.6.3. Define the measurements of the effectiveness of the process once undertaken.

13.1.6.4. Execution of the preventive action.

13.1.6.5. Evaluation of the plan using the defined measurements.

13.1.6.6. Verification of the effectiveness of the preventive action.

13.1.6.7. Close-out by documenting any permanent changes to the Quality System as a result of the Preventive Action. Documentation of Preventive Action is incorporated into the monthly QA reports, corrective action process, and management review.

13.1.7. Any Preventive Actions undertaken or attempted must be taken into account during the Annual Management Systems Review (Section 16). A highly detailed report is not required; however, a summary of success and failure within the preventive action program is sufficient to provide management with a measurement for evaluation.

13.2. Management Of Change

13.2.1. The Management of Change process is designed to manage significant events and changes that occur within the laboratory. Through these procedures, the potential risks inherent with a new event or change are identified and evaluated. The risks are minimized or eliminated through pre-planning and the development of preventive measures. The laboratory has a graded approach for managing change based based on the Management Systems Review.

14. CONTROL OF RECORDS

14.1. The laboratory maintains a records management system appropriate to its needs and that complies with applicable standards or regulations as required. The system produces unequivocal, accurate records that document all laboratory activities. The laboratory retains all original observations, calculations and derived data, calibration records and a copy of the analytical report for a minimum of five years after it has been issued.

14.2. Overview

14.2.1. The laboratory has established procedures for identification, collection, indexing, access, filing, storage, maintenance and disposal of quality and technical records. A record index is listed in Table 14-1. Quality records are maintained by the QA Department which is backed up as part of the regular network backup. Records are of two types--either electronic or hard-copy paper formats depending on whether the record is computer or hand generated (some records may be in both formats). Technical records are maintained by the Records Manager.

Table 14-1. Records Index (1)

Record Types 1:	Retention Time:

	Record Types 1:	Retention Time:
Technical Records	- Raw Data - Logbooks2 - Standards - Certificates - Analytical Records - MDLs/IDLs/DOCs - Lab Reports	5 Years from analytical report issue*
Official Documents	- Quality Assurance Manual (QAM) - Work Instructions - Policies - SOPs - Policy Memorandums - Manuals	5 Years from document retirement date*
QA Records	- Internal & External Audits/Responses - Certifications - Corrective/Preventive Actions - Management Reviews - Method & Software Validation / Verification Data - Data Investigation	5 Years from archival* Data Investigation: 5 years or the life of the affected raw data storage whichever is greater (beyond 5 years if ongoing project or pending investigation)
Project Records	- Sample Receipt & COC Documentation - Contracts and Amendments - Correspondence - QAPP - SAP - Telephone Logbooks - Lab Reports	5 Years from analytical report issue*
Administrative Records	Finance and Accounting	10 years
	EH&S Manual, Permits	7 years
	Disposal Records	Indefinitely
	Employee Handbook	Indefinitely
	Personnel files, Employee Signature & Initials, Administrative Training Records (e.g., Ethics)	Refer to HR Manual
	Administrative Policies Technical Training Records	7 years

1. *Record Types encompass hardcopy and electronic records.*
2. *Examples of logbook types: Maintenance, Instrument Run, Preparation (standard and samples), Standard and Reagent Receipt, Archiving, Balance Calibration, Temperature (hardcopy or electronic records).*

* Exceptions listed in Table 14-2.

14.2.2. All records are stored and retained in such a way that they are secure and readily retrievable at the laboratory facility that provides a suitable environment to prevent damage or deterioration and to prevent loss. All records must be protected against fire, theft, loss, environmental deterioration, and vermin. In the case of electronic records and electronic

or magnetic sources, storage media are protected from deterioration caused by magnetic fields and/or electronic deterioration.

14.2.3. Access to the data is limited to laboratory and company employees, and shall be documented with an access log. Records are maintained for a minimum of five years unless otherwise specified by a client or regulatory requirement.

14.2.4. For raw data and project records, record retention must be calculated from the date the project report is issued. For other records, such as Controlled Documents, QA, or Administrative Records, the retention time is calculated from the date the record is formally retired. Records related to the programs listed in Table 14-2 have lengthier retention requirements and are subject to the requirements in Section 14.1.3.

14.3. Programs with Longer Retention Requirements

14.3.1. Some regulatory programs have longer record retention requirements than the standard record retention time. These are detailed in Table 14-2 with their retention requirements. In these cases, the longer retention requirement is enacted. If special instructions exist such that client data cannot be destroyed prior to notification of the client, the container or box containing that data is marked as to who to contact for authorization prior to destroying the data.

Note: For the Ohio VAP program the laboratory is required to notify Ohio EPA of its intent to dispose of any records.

Table 14-2. Special Record Retention Requirements

Program	Retention Requirement
Ohio – Drinking Water	5 years (project records) 10 years – radio chemistry (project records)
Michigan Department of Environmental Quality – all environmental data	10 years
OSHA - 40 CFR Part 1910	30 years
TSCA - 40 CFR Part 792	10 years after publication of final test rule or negotiated test agreement and others as negotiated.
Ohio Voluntary Action Program	10 years

Note: Extended retention requirements must be noted with the archive documents or addressed in facility-specific records retention procedures.

14.3.2. The laboratory has procedures to protect and back-up records stored electronically and to prevent unauthorized access to or amendment of these records. All analytical data is maintained as hardcopy or in a secure readable electronic format. For analytical reports that are maintained as copies in PDF format, refer to Section 19.14.1 for more information.

14.3.3. The record-keeping system allows for historical reconstruction of all laboratory activities that produced the analytical data, as well as rapid recovery of historical data. (Records stored off site should be accessible within two days of a request for such records). The history of the sample from when the laboratory took possession of the samples must be readily understood through the documentation. This must include inter-laboratory transfers of samples and/or extracts.

14.3.4. The records include the identity of personnel involved in sampling, sample receipt, preparation, or testing. All analytical work contains the initials (at least) of the personnel involved. The laboratory copy of the Chain-of-Custody is stored with the invoice and the Work Order sheet generated by LIMS. The Chain-of-Custody would indicate the name of the sampler. If any sampling notes are provided with a Work Order, they are kept with this package.

14.3.5. All information relating to the laboratory facilities equipment, analytical test methods, and related laboratory activities, such as sample receipt, sample preparation, or data verification are documented.

14.3.6. The record-keeping system facilitates the retrieval of all working files and archived records for inspection and verification purposes, e.g., set format for naming electronic files, set format for what is included with a given analytical data set. SOP NC-QA-019, Records Information Management, outlines this procedure. Instrument data is stored sequentially by instrument. A given day's analyses are maintained in the order of the analysis. Run logs are maintained for each instrument or method; each day's run long or instrument sequence is stored with the data to aid in re-constructing an analytical sequence. Where an analysis is performed without an instrument, bound logbooks or bench sheets are used to record and file data. Standard and reagent information is entered into LIMS for each method as required.

14.3.7. Changes to hardcopy records must follow the procedures outlined in Sections 12 and 19. Changes to electronic records in LIMS or instrument data are recorded in audit trails.

14.3.8. The reason for a signature or initials on a document is clearly indicated in the records such as "Sampled by," "Prepared by," "Reviewed by", or "Analyzed by".

14.3.9. All generated data except those that are generated by automated data collection systems, are recorded directly, promptly and legibly in permanent dark ink.

14.3.10. Hard-copy data may be scanned into PDF format for record storage as long as the scanning process can be verified in order to ensure no data is lost, and the data files and storage media must be tested to verify the laboratory's ability to retrieve the information prior to the destruction of the hard-copy which was scanned.

14.3.11. Also refer to Section 19.14.1, "Computer and Electronic Data Related Requirements".

14.4. Technical And Analytical Records

14.4.1. The laboratory retains records of original observations, derived data and sufficient information to establish an audit trail, calibration records, staff records and a copy of each analytical report issued, for a minimum of five years unless otherwise specified by a client or regulatory requirement (refer to Section 15.1). The records for each analysis must contain sufficient information to enable the analysis to be repeated under conditions as close as possible to the original. The records must include the identity of laboratory personnel responsible for the sampling, performance of each analysis and reviewing results.

14.4.2. Observations, data, and calculations are recorded in real-time at the time they are made and are identifiable to the specific task.

14.4.3. Changes to hardcopy records must follow the procedures outlined in Sections 12 and 19. Changes to electronic records in LIMS or instrument data are recorded in audit trails. The essential information to be associated with analysis, such as strip charts, tabular printouts, computer data files, analytical notebooks, and run logs, include:

14.5. Laboratory sample ID code

14.5.1. Date of analysis. Time of analysis is also required if the holding time is 72 hours or less, or when time-critical steps are included in the analysis (e.g., drying times, incubations, etc.); instrumental analyses have the date and time of analysis recorded as part of their general operations. Where a time critical step exists in an analysis, location for such a time is included as part of the documentation.

14.5.2. Instrumentation identification and instrument operating conditions/parameters. Operating conditions/parameters are typically recorded in instrument maintenance logs where available. Instrument logs may be in electronic format.

14.5.3. Analysis type

14.5.4. All manual calculations and manual integrations

14.5.5. Analyst or operator initials/signature

14.5.6. Sample preparation, including cleanup, separation protocols, incubation periods, ID codes, volumes, weights, instrument printouts, meter readings, calculations, reagents

14.5.7. Test results

14.5.8. Standard and reagent origin, ID codes, and dates of receipt, preparation, and use

14.5.9. Calibration criteria, frequency, and acceptance criteria

14.5.10. Data and statistical calculations, review, confirmation, interpretation, assessment and reporting conventions

14.5.11. Quality control protocols and assessment

14.5.12. Electronic data security, software documentation and verification, software and hardware audits, backups, and records of any changes to automated data entries

14.5.13. Method performance criteria including expected quality control requirements. These are indicated both in the LIMS and on specific analytical report formats.

14.5.14. All logbooks used during receipt, preparation, storage, analysis, and reporting of samples or monitoring of support equipment shall undergo a documented supervisory or peer review on a monthly basis.

14.6. Laboratory Support Activities

14.6.1. In addition to documenting all the above-mentioned activities, the following are retained QA records and project records (previous discussions in this section relate where and how these data are stored):

14.6.2. All original raw data, whether hard-copy or electronic, for calibrations, samples and quality control measures, including analysts' work sheets and data output records (chromatograms, strip charts, and other instrument response readout records)

14.6.3. A written description or reference to the specific test method used which includes a description of the specific computational steps used to translate parametric observations into a reportable analytical value

14.6.4. Copies of final reports

14.6.5. Archived SOPs

14.6.6. Correspondence relating to laboratory activities for a specific project

14.6.7. All Corrective Action reports, audits and audit responses

14.6.8. Proficiency test results and raw data

14.6.9. Results of data review, verification, and cross-checking procedures

14.7. Sample Handling Records

14.7.1. Records of all procedures to which a sample is subjected while in the possession of the laboratory are maintained. These include, but are not limited to, records pertaining to:

14.7.2. Sample preservation including appropriateness of sample container and compliance with holding time requirement

14.7.3. Sample identification, receipt, acceptance or rejection and login

14.7.4. Sample storage and tracking including shipping receipts, sample transmittal / COC forms

14.7.5. Procedures for the receipt and retention of samples, including all provisions necessary to protect the integrity of samples.

14.8. Administrative Records

14.8.1. The laboratory also maintains the administrative records in either electronic or hard-copy form Refer to Table 14-1.

14.9. Records Management, Storage, And Disposal

14.9.1. All records (including those pertaining to test equipment), certificates, and reports are safely stored, held secure, and in confidence to the client. Certification-related records are available to the accrediting body upon request.

14.9.2. All information necessary for the historical reconstruction of data is maintained by the laboratory. Records that are stored only on electronic media must be supported by the hardware and software necessary for their retrieval.

14.9.3. Records that are stored or generated by computers or personal computers have hardcopy, write-protected backup copies, or an electronic audit trail controlling access.

14.9.4. The laboratory has a record management system for control of laboratory notebooks, instrument logbooks, standards logbooks, and records for data reduction, validation, storage, and reporting. Laboratory notebooks are issued on a per analysis basis, and are numbered sequentially.

14.10. Transfer Of Ownership

14.10.1. In the event the laboratory transfers ownership or goes out of business, the laboratory shall ensure that the records are maintained or transferred according to client's instructions. Upon ownership transfer, record retention requirements shall be addressed in the ownership transfer agreement and the responsibility for maintaining archives is clearly established. In addition, in cases of bankruptcy, appropriate regulatory and state legal requirements concerning laboratory records must be followed. In the event of the closure of the laboratory, all records will revert to the control of the corporate headquarters. Should the entire company cease to exist, as much notice as possible will be given to clients and the accrediting bodies who have worked with the laboratory during the previous five years of such action.

14.11. Records Disposal

14.11.1. Records are removed from the archive and destroyed after five years, unless otherwise specified by a client or regulatory requirement. On a project-specific or program basis, clients may need to be notified prior to record destruction. Records are destroyed in a manner that ensures their confidentiality such as shredding, mutilation or incineration (refer to Tables 14-1 and 14-2).

14.11.2. Electronic copies of records must be destroyed by erasure or physically damaging off-line storage media so no records can be read.

14.11.3. If a third party records management company is hired to dispose of records, a "Certificate of Destruction" is required.

15. AUDITS

15.1. Internal Audits

15.1.1. Internal audits are performed to verify that laboratory operations comply with the requirements of the lab's quality system and with the external quality programs under which the laboratory operates. Audits are planned and organized by the QA staff. Personnel conducting the audits should be independent of the area being evaluated. Auditors will have sufficient authority, access to work areas, and organizational freedom necessary to observe all activities affecting quality and to report the assessments to laboratory management and when requested to corporate management.

15.1.2. Audits are conducted and documented as described in TestAmerica Corporate SOP
CW-Q-S-003 on performing Internal Auditing. The types and frequency of routine internal audits are described in Table 15-1. Special or ad hoc assessments may be conducted as needed under the direction of the QA staff.

Table 15-1. Types of Internal Audits and Frequency

Description	Performed by	Frequency
Quality Systems Audits	QA Department, QA approved designee, or Corporate QA	All areas of the laboratory annually
Method Audits	Joint responsibility: QA Manager or designee with assistance by the Technical Director or designee (refer to CA-Q-S-004)	Method audits frequency: 50% of methods annually 100% of methods annually (DoD Labs)
QA Technical Audits	Joint responsibility: QA manager or designee Technical Manager or Designee (Refer to CW-Q-S-003)	Technical Audits Frequency: 50% of methods annually
SOP Method Compliance	Joint responsibility: QA Manager or Designee D) Technical Manager or Designee (Refer to CW-Q-S-003)	SOP Compliance Review Frequency Every 2 years 100% of SOPs annually (DoD Labs)
Special	QA Department or Designee	Surveillance or spot checks performed as needed, e.g., to confirm corrective actions from other audits
Performance Testing	Analysts with QA oversight	Two successful per year for each TNI field of testing or as dictated by regulatory requirements

15.2. Annual Quality Systems Audit

15.2.1. An annual quality systems audit is required to ensure compliance to analytical methods and SOPs, TestAmerica's Data Integrity and Ethics Policies, TNI quality systems, client and state requirements, and the effectiveness of the internal controls of the analytical process, including but not limited to, data review, quality controls, preventive action, and corrective action. The completeness of earlier corrective action is assessed for effectiveness and sustainability. The audit is divided into sections for each operating or support area of the lab, and each section is comprehensive for a given area. The area audits may be performed on a rotating schedule throughout the year to ensure adequate coverage of all areas. This schedule may change as situations in the laboratory warrant.

Note: Part of the quality systems audit relates to regulatory compliance. An assessment of the laboratory's compliance to regulatory requirements

is performed by Corporate QA through monthly management reports, review of client and regulatory concerns, and also through periodic on-site evaluations.

15.3. QA Technical Audits

15.3.1. QA technical audits are based on client projects, associated sample delivery groups, and the methods performed. Reported results are compared to raw data to verify the authenticity of results. The validity of calibrations and QC results are compared to data qualifiers, footnotes, and case narratives. Documentation is assessed by examining run logs and records of manual integrations. Manual calculations are checked. Where possible, electronic audit Miner programs (e.g., Chrom AuditMiner) are used to identify unusual manipulations of the data deserving closer scrutiny. QA technical audits must include all methods within a two-year period.

15.4. SOP Method Compliance

15.4.1. Compliance of all SOPs with the source methods and compliance of the operational groups with the SOPs must be assessed by the Technical Director and the QA department at least every two years. (Annually for methods and administrative SOPs related to DoD programs.) The work of each newly hired analyst is assessed within three months of working independently, (e.g., completion of method IDOC). In addition, as analysts add methods to their capabilities, (new IDOC) reviews of the analyst work products must be performed within three months of completing the documented training.

15.5. Special Audits

15.5.1. Special audits are conducted on an as needed basis, generally as a follow up to specific issues such as client complaints, corrective actions, PT results, data audits, system audits, validation comments, regulatory audits or suspected ethical improprieties. Special audits are focused on a specific issue, and report format, distribution, and timeframes are designed to address the nature of the issue. Special audits will also be performed when new methods and/or instrumentation is implemented.

15.6. Performance Testing

15.6.1. The laboratory participates semi-annually in performance audits conducted through the analysis of PT samples provided by a third party. The laboratory generally participates in the following types of PT studies—non potable water and soil.

15.6.2. It is TestAmerica's policy that PT samples be treated as typical samples in the production process. Furthermore, where PT samples present special or unique problems, in the regular production process they may need to be treated differently, as would any special or unique request submitted by any client. The QA Manager must be consulted and in

agreement with any decisions made to treat a PT sample differently due to some special circumstance.

15.6.3. Written responses to unacceptable PT results are required. In some cases it may be necessary for blind QC samples to be submitted to the laboratory to show a return to control.

15.7. External Audits

15.7.1. External audits are performed when certifying agencies or clients conduct on-site inspections or submit performance testing samples for analysis. It is TestAmerica's policy to cooperate fully with regulatory authorities and clients. The laboratory makes every effort to provide the auditors with access to personnel, documentation, and assistance. Laboratory group leaders are responsible for providing corrective actions to the QA Manager who coordinates the response for any deficiencies discovered during an external audit. Audit responses are due in the time allotted by the client or agency performing the audit. When requested, a copy of the audit report and the laboratory's Corrective Action plan must be forwarded to Corporate Quality.

15.7.2. The laboratory cooperates with clients and their representatives to monitor the laboratory's performance in relation to work performed for the client. The client may only view data and systems related directly to the client's work. All efforts are made to keep other client information confidential.

15.8. Confidential Business Information (CBI) Considerations

15.8.1. During on-site audits, auditors may come into possession of information claimed as business confidential. A business confidentiality claim is defined as "a claim or allegation that business information is entitled to confidential treatment for reasons of business confidentiality or a request for a determination that such information is entitled to such treatment." When information is claimed as business confidential, the laboratory must place on (or attach to) the information at the time it is submitted to the auditor, a cover sheet, stamped or typed legend or other suitable form of notice, employing language such as "trade secret", "proprietary" or "company confidential". Confidential portions of documents otherwise non-confidential must be clearly identified. CBI may be purged of references to client identity by the responsible laboratory official at the time of removal from the laboratory. However, sample identifiers may not be obscured from the information. Additional information regarding CBI can be found in within the 2009 TNI standards.

15.9. Audit Findings

15.9.1. Audit findings are documented using the Corrective Action process and spreadsheet. The laboratory's Corrective Action responses for both types of audits may include action plans that could not be completed within a

predefined timeframe. In these instances, a completion date must be set and agreed to by Operations management and the QA Manager.

15.9.2. Developing and implementing Corrective Action to findings is the responsibility of the Department Manager where the finding originated. Findings that are not corrected by specified due dates are reported monthly to management in the QA monthly report. When requested, a copy of the audit report and the laboratory's Corrective Action plan must be forwarded to Corporate Quality.

15.9.3. If any audit finding casts doubt on the effectiveness of the operations or on the correctness or validity of the laboratory's test results, the laboratory must take timely corrective action, and must notify clients in writing if the investigations show that the laboratory results have been affected. Once corrective action is implemented, a follow-up audit is scheduled to ensure that the problem has been corrected.

15.9.4. Clients must be notified promptly in writing, of any event such as the identification of defective measuring or test equipment that casts doubt on the validity of results given in any test report or amendment to a test report. The investigation must begin within 24 hours of discovery of the problem and all efforts are made to notify the client within two weeks after the completion of the investigation.

16. MANAGEMENT REVIEWS

16.1. Quality Assurance Report

16.1.1. A comprehensive QA Report must be prepared each month by the laboratory's QA Department and forwarded to the Laboratory Director and Corporate Quality Director, as well as the VP of Operations. All aspects of the QA system are reviewed to evaluate the suitability of policies and procedures. During the course of the year, the Laboratory Director, VP of Operations, or Corporate QA may request that additional information be added to the report.

16.1.2. On a monthly basis, Corporate QA compiles information from all the monthly laboratory reports. The Corporate Quality Directors prepare a report that includes a compilation of all metrics and notable information and concerns regarding the QA programs within the laboratories. The report also includes a listing of new regulations that may potentially impact the laboratories. This report is presented to the Senior Management Team and General Managers.

16.2. Annual Management Review

16.2.1. The Senior Lab Management Team (Laboratory Director, Technical Director, Operations Manager, QA Manager, HR Supervisor, PM Manager) conducts a review annually of its quality systems and LIMS to ensure its continuing suitability and effectiveness in meeting client and regulatory requirements and to introduce any necessary changes or

improvements. It will also provide a platform for defining goals, objectives, and action items that feed into the laboratory planning system. Corporate Operations and Corporate QA personnel may be included in this meeting at the discretion of the Laboratory Director. The LIMS review consists of examining any audits, complaints or concerns that have been raised through the year that are related to the LIMS. The laboratory must summarize any critical findings that cannot be solved by the lab, and report them to Corporate IT.

16.2.2. The Management Systems Review (Corporate SOP CW-Q-S-004 and Work Instruction CW-Q-WI-003) uses information generated during the preceding year to assess the "big picture" by ensuring that routine actions taken and reviewed on a monthly basis are not components of larger systematic concerns. The monthly review should keep the quality systems current and effective; therefore, the annual review is a formal senior management process to review specific existing documentation. Significant issues from the following documentation are compiled or summarized by the QA Manager prior to the review meeting:

16.2.2.1. Matters arising from the previous annual review

16.2.2.2. Prior Monthly QA Reports issues

16.2.2.3. Laboratory QA Metrics

16.2.2.4. Review of report reissue requests

16.2.2.5. Review of client feedback and complaints

16.2.2.6. Issues arising from any prior management or staff meetings

16.2.2.7. Minutes from prior Senior Lab Management Team meetings. Issues that may be raised from these meetings include:

16.2.2.7.1. Adequacy of staff, equipment and facility resources

16.2.2.7.2. Adequacy of policies and procedures

16.2.2.7.3. Future plans for resources and testing capability and capacity

16.2.2.8. The annual internal double blind PT program sample performance (if performed)

16.2.2.9. Compliance to the Ethics Policy and Data Integrity Plan, including any evidence/incidents of inappropriate actions or vulnerabilities related to data Integrity

16.2.2.10. A management system review report is generated by the QA Manager and management. The report is distributed to the

appropriate VP of Operations, and Corporate Quality Director. The report includes, but is not limited to:

16.2.2.11. The date of the review and the names and titles of participants

16.2.2.12. A reference to the existing data quality related documents and topics that were reviewed

16.2.2.13. Quality system or operational changes or improvements that will be made as a result of the review, e.g., an implementation schedule including assigned responsibilities for the changes (Action Table)

16.2.2.14. Changes to the quality systems requiring update to the laboratory QA Manual must be included in the next revision of the QA Manual.

16.3. Potential Integrity Related Managerial Reviews

16.3.1. Potential integrity issues (data or business related) must be handled and reviewed in a confidential manner until such time as a follow-up evaluation, full investigation, or other appropriate actions have been completed and issues clarified. TestAmerica's Corporate Data Investigation/ Recall SOP CW-L-S-002 must be followed. All investigations that result in finding inappropriate activity are documented and include any disciplinary actions involved, corrective actions taken, and all appropriate notifications of clients.

16.3.2. TestAmerica's CEO, Executive VP of Operations, VP of Client & Technical Services, VPs of Operations and Quality Directors receive a monthly report from the Corporate Quality and EHS Directo summarizing any current data integrity or data recall investigations. The VPs of Operations are also made aware of progress on these issues for their specific labs.

17. PERSONNEL

17.1. The laboratory's management believes that its highly qualified and professional staff is the single most important aspect in assuring a high level of data quality and service. The staff consists of professionals and support personnel as outlined in the organization chart in Figure 4-1.

17.2. All personnel must demonstrate competence in the areas where they have responsibility. Any staff that is undergoing training must have appropriate supervision until they have demonstrated their ability to perform their job function on their own. Staff must be qualified for their tasks based on appropriate education, training, experience and/or demonstrated skills as required.

17.3. The laboratory employs sufficient personnel with the necessary education, training, technical knowledge and experience for their assigned responsibilities.

17.4. All personnel are responsible for complying with all QA/QC requirements that pertain to the laboratory and their area of responsibility. Each staff member must have a combination of experience and education to adequately demonstrate a specific knowledge of their particular area of responsibility. Technical staff must also have a general knowledge of lab operations, test methods, QA/QC procedures and records management.

17.5. Laboratory management is responsible for formulating goals for lab staff with respect to education, training and skills and ensuring that the laboratory has a policy and procedures for identifying training needs and providing training of personnel. The training must be relevant to the present and anticipated responsibilities of the lab staff.

17.6. The laboratory only uses personnel that are employed by or under contract to, the laboratory. Contracted personnel, when used, must meet competency standards of the laboratory and work in accordance with the laboratory's quality system.

17.7. Education And Experience Requirements For Technical Personnel

17.7.1. The laboratory makes every effort to hire analytical staff that posses a college degree (AA, BA, BS) in an applied science with some chemistry in the curriculum. Exceptions can be made based upon the individual's experience and ability to learn. There are competent analysts and technicians in the industry who have not earned a college degree. Selection of qualified candidates for laboratory employment begins with documentation of minimum education, training, and experience prerequisites needed to perform the prescribed task. Minimum education and training requirements for TestAmerica employees are outlined in job descriptions and are generally summarized for analytical staff in the table below.

17.7.2. The laboratory maintains job descriptions for all personnel who manage, perform or verify work affecting the quality of the environmental testing the laboratory performs. Job Descriptions are located on the TestAmerica intranet "Human Resources" web-page (also see Section 4 for position descriptions/responsibilities).

17.7.3. Experience and specialized training are occasionally accepted in lieu of a college degree (basic lab skills such as using a balance or quantitation techniques, etc. are also considered

17.7.4. As a general rule for analytical staff:

Specialty	Education	Experience

Specialty	Education	Experience
Extractions, Digestions, some electrode methods (pH, DO, Redox, etc.), or Titrimetric and Gravimetric Analyses	H.S. Diploma	On the job training (OJT)
CVAA, FLAA, Single component or short list Chromatography (e.g., Fuels, BTEX-GC, IC	A college degree in an applied science or 2 years of college and at least one year of college chemistry	Or 2 years prior analytical experience is required
ICP, ICPMS, Long List or complex chromatography (e.g., Pesticides, PCB, Herbicides, HPLC, etc.), GCMS	A college degree in an applied science or 2 years of college chemistry	Or 5 years of prior analytical experience
Spectra Interpretation	A college degree in an applied science or 2 years of college chemistry	And 2 years relevant experience. Or 5 years of prior analytical experience
Group Leaders – General	Bachelors Degree in an applied science or engineering with 24 semester hours in chemistry An advanced (MS, PhD.) degree may substitute for one year of experience	And 2 years experience in environmental analysis of representative analytes for which they will oversee
Group Leader – Wet Chem only (no advanced instrumentation)	Associate degree in an applied science or engineering or 2 years of college with 16 semester hours in chemistry	And 2 years relevant experience

17.7.5. When an analyst does not meet these requirements, they can perform a task under the direct supervision of a qualified analyst, peer reviewer or Department Manager, and are considered an analyst in training. The person supervising an analyst in training is accountable for the quality of the analytical data and must review and approve data and associated corrective actions.

17.8. Training

17.8.1. The laboratory is committed to furthering the professional and technical development of employees at all levels.

17.8.2. Orientation to the laboratory's policies and procedures, in-house method training, and employee attendance at outside training courses and conferences all contribute toward employee proficiency. Below are examples of various areas of required employee training:

Required Training	Time Frame*	Employee Type
New Hire Orientation	Immediately	All
Environmental Health & Safety Orientation	Prior to lab work	All
Environmental Health & Safety Orientation Follow-up Test	30-60 days after hire	All
Environmental Health & Safety Training	Refer to EH&S Manual	All
Ethics – New Hires	1 week of hire	All
Ethics - Comprehensive	90 days of hire	All
Data Integrity	30 days of hire	Technical and PMs
Quality Assurance	90 days of hire	All
Ethics – Comprehensive Refresher	Annually	All
Initial Demonstration of Capability (DOC)	Prior to unsupervised method performance	Technical

17.8.3. The laboratory maintains records of relevant authorization/competence, education, professional qualifications, training, skills and experience of technical personnel (including contracted personnel) as well as the date that approval/authorization was given. These records are kept on file at the laboratory. Also refer to “Demonstration of Capability” in Section 19.

17.8.4. The training of technical staff is kept up to date by:

17.8.4.1. Each employee must have documentation in their training file that they have read, understood and agreed to follow the most recent version of the laboratory QA Manual, and SOPs, and any work instructions involving their area of responsibility. This documentation is updated as the various documents are revised.

17.8.4.2. Documentation from any training courses or workshops on specific equipment, analytical techniques or other relevant topics are maintained in the employee’s training file.

17.8.4.3. Documentation of proficiency (refer to Section 19)

17.8.4.4. An Ethics Agreement signed by each staff member (renewed each year) and evidence of annual ethics training

17.8.4.5. A Confidentiality Agreement signed by each staff member at the time of employment

17.8.4.6. Human Resources maintains documentation and attestation forms on employment status & records; benefit programs; timekeeping/payroll; and employee conduct, e.g., ethics. This

information is maintained in the employee's secured personnel file.

17.8.5. Evidence of successful training could include such items as:

17.8.5.1. Adequate documentation of training within operational areas, including one-on-one technical training for individual technologies, and particularly for people cross-trained.

17.8.5.2. Analysts' knowledge of the QA Manual for quality issues

17.8.5.3. Analysts following SOPs, i.e., practice matches SOPs

17.8.5.4. Analysts regularly communicate to group leaders and QA if SOPs need revision rather than waiting for auditors to find problems.

17.8.6. Further details of the laboratory's analyst training program are described in the Laboratory Training SOP NC-QA-028, Employee Orientation and Training.

17.9. Data Integrity And Ethics Training Program

17.9.1. Establishing and maintaining a high ethical standard is an important element of a Quality System. Ethics and data integrity training is integral to the success of TestAmerica and is provided for each employee at TestAmerica. It is a formal part of the initial employee orientation within one week of hire followed by technical data integrity training within 30 days, comprehensive training within 90 days, and annual refresher for all employees. Senior management at each facility performs the Ethics training for their staff.

17.9.2. In order to ensure that all personnel understand the importance TestAmerica places on maintaining high ethical standards at all times, TestAmerica has established a Corporate Ethics Policy (CW-L-P-004) and an Ethics Statement. All initial and annual training is documented by employee signature on the signed Ethics Statement/Agreement demonstrating that the employee has participated in the training and understands their obligations related to ethical behavior and data integrity.

17.9.3. Violations of this Ethics Policy will not be tolerated. Employees who violate this policy will be subject to disciplinary actions up to and including termination. Criminal violations may also be referred to the Government for prosecution. In addition, such actions could jeopardize TestAmerica's ability to do work on Government contracts; for that reason, TestAmerica has a zero tolerance approach to such violations.

17.9.3.1. Employees are trained as to the legal and environmental repercussions that result from data misrepresentation. Key topics covered in the presentation include:

17.9.3.2. Organizational mission and its relationship to the critical need for honesty and full disclosure in all analytical reporting

17.9.3.3. Ethics Policy

17.9.3.4. How and when to report ethical/data integrity issues. Confidential reporting.

17.9.3.5. Record keeping

17.9.3.6. Discussion regarding data integrity procedures

17.9.3.7. Specific examples of breaches of ethical behavior--peak shaving, altering data or computer clocks, improper macros, etc., accepting/offering kickbacks, illegal accounting practices, unfair competition/collusion

17.9.3.8. Internal monitoring. Investigations and data recalls

17.9.3.9. Consequences for infractions including potential for immediate termination, debarment, or criminal prosecution

17.9.3.10. Importance of proper written narration / data qualification by the analyst and project manager with respect to those cases where the data may still be usable but are in one sense or another partially deficient

17.9.4. Additionally, a Data Integrity Hotline (1-800-736-9407) is maintained by TestAmerica and administered by the Corporate Quality Department.

18. ACCOMMODATIONS AND ENVIRONMENTAL CONDITIONS

18.1. The laboratory is a 54,440 sq. ft. secure laboratory facility with controlled access and designed to accommodate an efficient workflow and to provide a safe and comfortable work environment for employees. All visitors sign in and are escorted by laboratory personnel. Access is controlled by various measures.

18.2. The laboratory is equipped with structural safety features. Each employee is familiar with the location, use, and capabilities of general and specialized safety features associated with their workplace. The laboratory provides and requires the use of protective equipment including safety glasses, protective clothing, gloves, etc. OSHA and other regulatory agency guidelines regarding required amounts of bench and fume hood space, lighting, ventilation (temperature and humidity-controlled), access, and safety equipment are met or exceeded.

18.3. Traffic flow through sample preparation and analysis areas is minimized to reduce the likelihood of contamination. Adequate floor space and bench top area

is provided to allow unencumbered sample preparation and analysis space. Sufficient space is also provided for storage of reagents and media, glassware, and portable equipment. Ample space is also provided for refrigerated sample storage before analysis and archival storage of samples after analysis. Laboratory HVAC and deionized water systems are designed to minimize potential trace contaminants.

18.4. The laboratory is separated into specific areas for sample receiving, sample preparation, volatile organic sample analysis, non-volatile organic sample analysis, inorganic sample analysis, and administrative functions.

18.5. Environment

18.5.1. Laboratory accommodation, test areas, energy sources, and lighting are adequate to facilitate proper performance of tests. The facility is equipped with heating, ventilation, and air conditioning (HVAC) systems appropriate to the needs of environmental testing performed at this laboratory.

18.5.2. The environment in which these activities are undertaken does not invalidate the results or adversely affect the required accuracy of any measurements.

18.5.3. The laboratory provides for the effective monitoring, control and recording of environmental conditions that may affect the results of environmental tests as required by the relevant specifications, methods, and procedures. Such environmental conditions include humidity, voltage, temperature, and vibration levels in the laboratory. A 225KVA UPS is installed in the main electrical bus to provide at least 15 minutes of backup power in the event of a power failure. This unit also provides voltage and frequency control of lab and office power. A spike/surge arrestor is installed to protect against power surge/sag and lightning strikes. A 30 KW natural gas-fueled backup generator is installed to provide power to the I.T. area in the event of a power failure. Additionally, this generator provides power to two walk-in sample storage coolers and several other smaller sample storage coolers. Smaller portable generators are available to provide “spot power” where needed in the event of a power failure.

18.5.4. When any of the method or regulatory required environmental conditions change to an extent that they may adversely affect test results, analytical testing must be discontinued until the environmental conditions are returned to the required levels.

18.5.5. Environmental conditions of the offsite facility housing the computer network and LIMS are regulated to protect against raw data loss.

18.6. Work Areas

18.6.1. There is effective separation between neighboring areas when the activities therein are incompatible with each other. Examples include:

18.6.2. Volatile organic chemical handling areas, including sample preparation and waste disposal, and volatile organic chemical analysis areas.

18.6.3. Adequate measures are taken to ensure good housekeeping in the laboratory and to ensure that any contamination does not adversely affect data quality. These measures include regular cleaning to control dirt and dust within the laboratory.

18.6.4. Access to, and use of, all areas affecting the quality of analytical testing is defined and controlled by secure access to the laboratory building as described below in the Building Security section.

18.6.4.1. Access and entryways to the laboratory

18.6.4.2. Sample receipt areas

18.6.4.3. Sample storage areas

18.6.4.4. Chemical and waste storage areas

18.6.4.5. Data handling and storage areas

18.6.4.6. Sample processing areas

18.6.4.7. Sample analysis areas

18.7. Floor Plan

18.7.1. A floor plan can be found in Appendix 1.

18.8. Building Security

18.8.1. Building keys and keybadges are distributed to employees as necessary.

18.8.2. Visitors to the laboratory sign in and out in a visitor's logbook. A visitor is defined as any person who visits the laboratory who is not an employee of the laboratory. In addition to signing into the laboratory, the visitor is provided with any necessary personal protection equipment. The Environmental, Health and Safety Manual contains requirements for visitors and vendors. There are specific safety forms that must be reviewed and signed.

18.8.3. Visitors (with the exception of company employees) are escorted by laboratory personnel at all times, or the location of the visitor is noted in the visitor's logbook.

18.8.4. Signs are posted in the laboratory designating employee only areas - "Authorized employees beyond this point".

19. TEST METHODS AND METHOD VALIDATION

19.1. The laboratory uses methods that are appropriate to meet our clients' requirements and that are within the scope of the laboratory's capabilities. These include sampling, handling, transport, storage, and preparation of samples; and, where appropriate, an estimation of the measurement of uncertainty, as well as statistical techniques for analysis of environmental data.

19.2. Instructions are available in the laboratory for the operation of equipment as well as for the handling and preparation of samples. All instructions, Standard Operating Procedures (SOPs), reference methods and manuals relevant to the working of the laboratory are readily available to all staff. Deviations from published methods are documented (with justification) in the laboratory's approved SOPs. SOPs are submitted to clients for review at their request. Significant deviations from published methods require client approval and regulatory approval where applicable.

19.3. Standard Operating Procedures (Sops)

19.3.1. The laboratory maintains SOPs that accurately reflect all of the laboratory procedures such as assessing data integrity, taking corrective action, handling customer complaints, as well as all analytical methods and sampling procedures. The method SOPs are derived from promulgated/approved, published methods and are specifically adapted to the laboratory facility. Modifications or clarifications to published methods are clearly noted in the SOPs. All SOPs are controlled in the laboratory.

19.3.2. All SOPs contain a revision number, effective date, and appropriate approval signatures. Controlled copies are available to all staff.

19.3.3. Procedures for writing an SOP are included in TestAmerica's Corporate SOP CW-Q-S-002 entitled Writing a Standard Operating Procedure, or the Canton laboratory SOP NC-QA-027, Preparation and Management of Standard Operating Procedures.

19.3.4. SOPs are reviewed at a minimum of every two years (annually for DoD SOPs), and where necessary, revised to ensure continuing suitability and compliance with applicable requirements.

19.4. Laboratory Methods Manual

19.4.1. For each test method, the laboratory must have available the published referenced method(s) as well as the laboratory developed SOP(s).

Note: If more stringent standards or requirements are included in a mandated test method or regulation than those specified in this manual, the laboratory must demonstrate that such requirements are met. If it is not clear which requirements are more stringent, the standard from the method or regulation is to be followed. Any exceptions or deviations from the referenced methods or regulations are noted in the specific analytical SOP.

19.4.2. The laboratory maintains an SOP Index/Listing for both technical and non-technical SOPs. Technical SOPs are maintained to describe a specific test method. Non-technical SOPs are maintained to describe functions and processes not related to a specific test method.

19.5. Selection Of Methods

19.5.1. Since numerous methods and analytical techniques are available, continued communication between the client and laboratory is imperative to assure the correct methods are utilized. Once client methodology requirements are established, this and other pertinent information is summarized by the Project Manager. These mechanisms ensure that the proper analytical methods are applied when the samples arrive for log-in. For non-routine analytical services, e.g., special matrices, non-routine compound lists, etc., the method of choice is selected based on client needs and available technology. The methods selected should be capable of measuring the specific parameter of interest, in the concentration range of interest, and with the required precision and accuracy.

19.5.2. Sources of Methods

19.5.3. Routine analytical services are performed using standard EPA-approved methodology. In some cases, modification of standard approved methods may be necessary to provide accurate analyses of particularly complex matrices. When the use of specific methods for sample analysis is mandated through project or regulatory requirements, only those methods must be used.

19.5.4. When clients do not specify the method to be used or specific methods are not available, the methods that are used must be clearly validated and documented in an SOP and available to clients and/or the end user of the data.

19.5.5. The analytical methods used by the laboratory are those currently accepted and approved by the U. S. EPA and the state or territory from which the samples were collected. Reference methods include:

19.5.5.1. Method 1664, Revision A: N-Hexane Extractable Material (HEM; Oil and Grease) and Silica Gel Treated N-Hexane Extractable Material (SGT-HEM); Non-polar Material) by Extraction and Gravimetry, EPA-821-R-98-002, February 1999

19.5.5.2. Guidelines Establishing Test Procedures for the Analysis of Pollutants Under the Clean Water Act, and Appendix A-C; 40 CFR Part 136, USEPA Office of Water. Revised as of July 1, 1995, Appendix A to Part 136 - Methods for Organic Chemical Analysis of Municipal and Industrial Wastewater (EPA 600 Series)

19.5.5.3. Methods for Chemical Analysis of Water and Wastes, EPA 600 (4-79-020), 1983.

19.5.5.4. Methods for the Determination of Inorganic Substances in Environmental Samples, EPA-600/R-93/100, August 1993.

19.5.5.5. Methods for the Determination of Metals in Environmental Samples, EPA/600/4-91/010, June 1991. Supplement I: EPA-600/R-94/111, May 1994.

19.5.5.6. Standard Methods for the Examination of Water and Wastewater, 18th/19th /20th edition/ on-line edition Eaton, A.D. Clesceri, L.S. Greenberg, A.E. Eds; American Water Works Association, Water Pollution Control Federation, American Public Health Association: Washington, D.C.

19.5.5.7. Test Methods for Evaluating Solid Waste Physical/Chemical Methods (SW846), Third Edition, September 1986, Final Update I, July 1992, Final Update IIA, August 1993, Final Update II, September 1994; Final Update IIB, January 1995; Final Update III, December 1996, Final Update IV, January 2008.

19.5.5.8. Annual Book of ASTM Standards, American Society for Testing & Materials (ASTM), Philadelphia, PA.

19.5.5.9. Code of Federal Regulations (CFR) 40, Parts 136, 141, 172, 173, 178, 179 and 261

19.5.6. The laboratory reviews updated versions to all the aforementioned references for adaptation based upon capabilities, client requirements, instrumentation, etc., and implements them as appropriate. As such, the laboratory strives to perform only the latest versions of each approved method as regulations allow or require.

19.5.7. Other reference procedures for non-routine analyses may include methods established by specific states (e.g., Underground Storage Tank methods), ASTM or equipment manufacturers. Sample type, source, and the governing regulatory agency requiring the analysis will determine the method utilized.

19.5.8. The laboratory must inform the client when a method proposed by the client may be inappropriate or out of date. After the client has been informed, and they wish to proceed contrary to the laboratory's recommendation, it must be documented.

19.6. Demonstration of Capability

19.6.1. Before the laboratory may institute a new method and begin reporting results, the laboratory must confirm that it can properly perform the method. In general, this demonstration does not test the performance of

the method in real world samples, but in an applicable and available clean matrix.

19.6.2. A demonstration of capability is performed (SOP NC-QA-028, Employee Orientation and Training) whenever there is a change in instrument type (e.g., new instrumentation), method, or personnel (e.g., analyst has not performed the test within the last 12 months).

19.6.3. The initial demonstration of capability (IDOC) must be thoroughly documented and approved by the department group leader and QA Manager prior to an analyst independently analyzing client samples. All associated documentation must be retained in accordance with the laboratories archiving procedures for analyst training documentation.

19.6.4. Before the laboratory can analyze client samples by an analytical method, there must be an approved SOP in place, a demonstration of satisfactory analyst performance must be completed, and an MDL study (where applicable) must be performed. There may be other additional requirements stated within the published method or regulations (i.e., retention time window study for GC methods like 8081).

Note: In some instances, a situation may arise where a client requests that an unusual analyte be reported using a method where this analyte is not normally reported. If the analyte is being reported for regulatory purposes, the method must meet all procedures outlined within this QA Manual (SOP, MDL, and Analyst IDOC/CDOC).

19.6.5. If the client states that the information is not for regulatory purposes, and is intended to screen for the presence of the analyte the result may be reported as long as the following criteria are met:

19.6.6. A low-level standard containing the non-routine analyte at the RL must be analyzed to verify the laboratory's (and method) capability to detect the analyte at the RL.

19.6.7. If the client states that a quantitative result is required, a multi-point calibration must be analyzed, and ICV/CCV criteria must be met (unless an ICV/CCV is not required by the method or criteria are per project DQOs).

19.6.8. The laboratory's nominal or default reporting limit (RL) is equal to the quantitation limit (QL), must be at or above the lowest non-zero standard in the calibration curve (low standard at or below the QL)and must be reliably determined. Project RLs are client specified reporting levels which may be higher than the QL. Results reported below the QL must be qualified as estimated values. Also see Section 19.6.1.3, Relationship of Limit of Detection (LOD) to Quantitation Limit (QL).

Note: For Ohio VAP work, the term Reporting Limit will be used.

19.6.9. The client request is documented and the lab informs the client of its procedure for working with unusual compounds. The final report must be footnoted as “Reporting Limit based on the low standard of the calibration curve”.

19.7. Initial Demonstration of Capability (IDOC) Procedures

19.7.1. At least four aliquots must be prepared (including any applicable clean-up procedures) in the same fashion, and following all of the same procedures, as client samples, and analyzed according to the test method (either concurrently or over a period of days).

19.7.2. Using all of the results, calculate the mean recovery in the appropriate reporting units and the standard deviations for each parameter of interest. Refer to SOP NC-QA-028, Employee Orientation and Training, for details on this procedure.

Note: Results of successive LCS analyses can be used to fulfill the DOC requirement.

19.7.3. A certification statement (see Figure 19-1 as an example) must be used to document the completion of each IDOC. A copy of the certification is archived in the analyst’s training folder.

19.8. Laboratory-Developed Methods And Non-Standard Methods

19.8.1. Any new method developed by the laboratory must be fully defined in an SOP and validated by qualified personnel with adequate resources to perform the method. Method specifications and the relation to client requirements must be clearly conveyed to the client if the method is a non-standard method (not a published or routinely accepted method). The client must agree to the use of the non-standard method.

19.9. Validation Of Methods

19.9.1. Validation is the confirmation by examination and the provision of objective evidence that the particular requirements for a specific intended use are fulfilled.

19.9.2. All non-standard methods, laboratory designed/developed methods, standard methods used outside of their scope, and major modifications to published methods must be validated to confirm they are suitable for their intended use. The validation will be as extensive as necessary to meet the needs of the given application. The results are documented with the validation procedure used and contain a statement as to the fitness for use.

19.9.3. Method Validation and Verification Activities for All New Methods

19.9.3.1. While method validation can take various courses, the following activities can be required as part of method validation. Method

validation records are designated QC records and are archived accordingly.

19.9.4. Determination of Method Selectivity

19.9.4.1. Method selectivity is the demonstrated ability to discriminate the analyte(s) of interest from other compounds in the specific matrix or matrices. In some cases, to achieve the required selectivity for an analyte, a confirmation analysis is required as part of the method.

19.9.5. Determination of Method Sensitivity

19.9.5.1. Sensitivity can be both estimated and demonstrated. Whether a study is required to estimate sensitivity depends on the level of method development required when applying a particular measurement system to a specific set of samples. Where estimations and/or demonstrations of sensitivity are required by regulation or client agreement, such as the procedure in 40 CFR Part 136 Appendix B, under the Clean Water Act, these shall be followed.

19.9.6. Relationship of Limit of Detection (LOD) to the Limit of Quantitation (LOQ)

19.9.6.1. An important characteristic of expression of sensitivity is the difference in the LOD and the LOQ. The LOD is the minimum level at which the presence of an analyte can be reliably determined. The LOQ is the minimum concentration of analyte that can be quantitatively determined with acceptable precision and accuracy. For most instrumental measurement systems, there is a region where estimated is generated around the LOD (both above and below the estimated MDL or LOD) and below the LOQ. In this range, detection of an analyte may be confirmed, but quantification of the analyte is unreliable with unknown accuracy and precision. When an analyte is detected below the LOQ, and the presence of the analyte is confirmed by meeting the qualitative identification criteria for the analyte, the presence of the analyte can be reliably reported, but the amount of the analyte can only be estimated. If data are to be reported in this range, it must be done so with a qualification that denotes the estimated/uncertain nature of the result.

19.9.7. Determination of Interferences

19.9.7.1. A determination that the method is free from interferences in a blank matrix is performed.

19.9.8. Determination of Range

19.9.8.1. Where appropriate to the method, the quantitation range is determined by comparison of the response of an analyte in a

curve to established or targeted criteria. Generally the upper quantitation limit is defined by highest acceptable calibration concentration. The lower quantitation limit or LOQ cannot be lower than the lowest non-zero calibration level, and can be constrained by required levels of precision and accuracy.

19.9.9. Determination of Accuracy and Precision

19.9.9.1. Accuracy and precision studies are generally performed using replicate analyses, with a resulting percent recovery and measure of reproducibility (standard deviation, relative standard deviation) calculated and measured against a set of target criteria.

19.9.10. Documentation of Method

19.9.10.1. The method is formally documented in an SOP. If the method is a minor modification of a standard laboratory method that is already documented in an SOP, an SOP Attachment or Amendment, describing the specific differences in the new method is acceptable in place of a separate SOP.

19.9.11. Continued Demonstration of Method Performance

19.9.11.1. Continued demonstration of Method Performance is addressed in the SOP. Continued demonstration of method performance is generally accomplished by batch-specific QC samples such as LCS, method blanks, or PT samples.

19.10. Method Detection Limits (MDL)/ Limits Of Detection (LOD)

19.10.1. Method detection limits (MDL) are initially determined in accordance with 40 CFR Part 136, Appendix B, or alternatively by other technically valid practices that have been accepted by regulators. MDL is also sometimes referred to as Limit of Detection (LOD). The MDL theoretically represents the concentration level for each analyte within a method at which the Analyst is 99% confident that the true value is not zero. The MDL is determined for each analyte initially during the method validation process and updated as required in the analytical methods, whenever there is a significant change in the procedure or equipment, or based on project specific requirements (refer to Section 19.7.10). Generally, the analyst prepares at least seven replicates of solution spiked at one to five times the estimated method detection limit (most often at the lowest standard in the calibration curve) into the applicable matrix with all the analytes of interest. Each of these aliquots is extracted (including any applicable clean-up procedures) and analyzed in the same manner as the samples. Where possible, the seven replicates should be analyzed over 2-4 days to provide a more realistic MDL. To allow for some flexibility, this low level standard may be analyzed every batch or every week or some other frequency rather

than doing the study all at once. In addition, a larger number of data points may be used if the appropriate t-value multiplier is used.

19.10.2. Refer to the Corporate SOP CA-Q-S-006 or the laboratory's SOP NC-QA-021 for details on the laboratory MDL process.

Note: For Ohio VAP projects, the MDL procedure must also comply with OAC Rule 3745-300-01(A)(78).

19.11. Instrument Detection Limits (IDL)

19.11.1. The IDL is sometimes used to assess the reasonableness of the MDLs or in some cases required by the analytical method or program requirements. IDLs are most used in metals analyses but may be useful in the demonstration of instrument performance in other areas.

19.11.2. IDLs are calculated to determine an instrument's sensitivity independent of any preparation method. IDLs are calculated either by using seven replicate spike analyses, like MDL but without sample preparation, or by the analysis of ten instrument blanks and calculating three times the absolute value of the standard deviation.

19.11.3. If IDL is > than the MDL, it may be used as the reported MDL.

19.12. Verification Of Detection And Reporting Limits

19.12.1. Once the MDL is determined, it must be verified on each instrument used for the given method. TestAmerica defines the DoD QSM Detection Limit (DL) as being equal to the MDL. TestAmerica also defines the DoD QSM Limit of Detection (LOD) as being equal to the lowest concentration standard that successfully verifies the MDL, also referred to as the MDLV standard. MDL and MDLV standards are extracted/digested and analyzed through the entire analytical process. The MDL and MDLV determinations do not apply to methods that are not readily spiked (e.g. pH, turbidity, etc.) or where the lab does not report to the MDL. If the MDLV standard is not successful, then the laboratory will redevelop their MDL or perform and pass two consecutive MDLVs at a higher concentration and set the LOD at the higher concentration. Initial and quarterly verification is required for all methods listed in the laboratory's DoD ELAP Scope of Accreditation. Refer to the laboratory SOP NC-QA-021 or Corporate CA-Q-S-006 for further details.

19.12.2. The laboratory quantitation limit is equivalent to the DoD Limit of Quantitation (LOQ), which is at a concentration equal to or greater than the lowest non-zero calibration standard. The DoD QSM requires the laboratory to perform an initial characterization of the accuracy and precision at the LOQ and to perform quarterly LOQ verifications thereafter. If the quarterly verification results are not consistently within the three-standard deviation confidence limits established initially, then the accuracy and precision will be reevaluated and clients contacted for

any on-going projects. For DoD projects, TestAmerica makes a distinction between the Reporting Limit (RL) and the LOQ. The RL is a level at or above the LOQ that is used for specific project reporting purposes, as agreed to between the laboratory and the client. The RL cannot be lower than the LOQ concentration, but it may be higher.

19.13. Retention Time Windows

19.13.1. Most organic analyses and some inorganic analyses use chromatography techniques for qualitative and quantitative determinations. For every chromatography analysis each analyte will have a specific time of elution from the column to the detector. This is known as the analyte's retention time. The variance in the expected time of elution is defined as the retention time window. As the key to analyte identification in chromatography, retention time windows must be established on every column for every analyte used for that method. These records are kept in each department. Complete details are available in the laboratory SOPs.

19.14. Evaluation Of Selectivity

19.14.1. The laboratory evaluates selectivity by following the applicable analytical methods, which include mass spectral tuning, second column confirmation, ICP interelement interference checks, chromatography retention time windows, sample blanks, atomic absorption, or fluorescence profiles.

19.15. Estimation Of Uncertainty Of Measurement

19.15.1. Uncertainty is "a parameter associated with the result of a measurement, that characterizes the dispersion of the values that could reasonably be attributed to the measurement" (as defined by the International Vocabulary of Basic and General Terms in Metrology, ISO Geneva, 1993, ISBN 92-67-10175-1). Knowledge of the uncertainty of a measurement provides additional confidence in a result's validity. Its value accounts for all the factors which could possibly affect the result, such as adequacy of analyte definition, sampling, matrix effects and interferences, climatic conditions, variances in weights, volumes, and standards, analytical procedure, and random variation. Some national accreditation organizations require the use of an "expanded uncertainty," the range within which the value of the measurement is believed to lie within at least a 95% confidence level with the coverage factor k=2.

19.15.2. Uncertainty is not error. Error is a single value, the difference between the true result and the measured result. On environmental samples, the true result is never known. The measurement is the sum of the unknown true value and the unknown error. Unknown error is a combination of systematic error, or bias, and random error. Bias varies predictably, constantly, and independently from the number of measurements. Random error is unpredictable, assumed to be

Gaussian in distribution, and reducible by increasing the number of measurements.

19.15.3. The minimum uncertainty associated with results generated by the laboratory within a specified concentration range can be determined by using the Laboratory Control Sample (LCS) accuracy range for a given analyte. The LCS limits are used to assess the performance of the measurement system since they take into consideration all of the laboratory variables associated with a given test over time (except for variability associated with the sampling and the variability due to matrix effects). The percent recovery of the LCS is compared either to the method-required LCS accuracy limits or to the statistical, historical, in-house LCS accuracy limits.

19.15.4. To calculate the uncertainty for the specific result reported, multiply the result by the decimal of the lower end of the LCS range percent value for the lower end of the uncertainty range, and multiply the result by the decimal of the upper end of the LCS range percent value for the upper end of the uncertainty range. These calculated values represent uncertainties at approximately the 99% confidence level with a coverage factor of k = 3. As an example, for a reported result of 1.0 mg/L with an LCS recovery range of 50 to 150%, the estimated uncertainty in the result would be 1.0 ± 0.5 mg/l.

19.15.5. In the case where a well-recognized test method specifies limits to the values of major sources of uncertainty of measurement, e.g., 524.2, 525, etc., and specifies the form of presentation of calculated results, no further discussion of uncertainty is required.

19.16. Sample Reanalysis Guidelines

19.16.1. Because there is a certain level of uncertainty with any analytical measurement, a sample repreparation (where appropriate) and subsequent analysis (hereafter referred to as 'reanalysis') may result in either a higher or lower value from an initial sample analysis. There are also variables that may be present (e.g., sample non-homogeneity, analyte precipitation or other loss over time, etc.) that may affect the results of a reanalysis. Based on the above comments, the laboratory will reanalyze samples at a client's request with the following caveats. Client specific Contractual Terms & Conditions for reanalysis protocols may supersede the following items.

19.16.2. Homogenous samples: If a re-analysis agrees with the original result to within the RPD limits for MS/MSD or Duplicate analyses, or within + 1 reporting limit for samples < 5x the reporting limit, the original analysis will be reported. At the client's request, both results may be reported on the same report but not on two separate reports.

19.16.3. If the re-analysis does not agree (as defined above) with the original result, then the laboratory will investigate the discrepancy and reanalyze

the sample a third time for confirmation, if sufficient sample is available. The three results are then compared to determine the most reliable/usable result(s).

19.16.4. Any potential charges related to reanalysis are discussed in the contract terms and conditions or discussed at the time of the request. The client will typically be charged for reanalysis unless it is determined that the lab was in error.

19.16.5. Due to the potential for increased variability, reanalysis may not be applicable to Non-homogenous, Encore, and Sodium Bisulfate preserved samples. See the Group leader, if unsure.

19.17. Control Of Data

19.17.1. The laboratory has policies and procedures in place to ensure the authenticity, integrity, and accuracy of the analytical data generated.

19.18. Computer and Electronic Data Related Requirements

19.18.1. The three basic objectives of our computer security procedures and policies are shown below. The laboratory is currently running the TALS LIMS which is an in-house developed LIMS system that has been highly customized to meet the needs of the laboratory. It is referred to as LIMS for the remainder of this section. The LIMS utilizes Microsoft SQL, which is a relational database platform. It is referred to as Database for the remainder of this section.

19.19. Maintain the Database Integrity

19.19.1. Assurance is made that data is reliable and accurate through data verification (review) procedures, password-protecting access, anti-virus protection, data change requirements, as well as an internal LIMS permissions procedure.

19.19.2. LIMS Database Integrity is achieved through data input validation, internal user controls, and data change requirements.

19.19.3. Spreadsheets and other software developed in-house must be verified with documentation through hand calculations prior to use. Cells containing calculations must be lock-protected and controlled.

19.19.4. Instrument hardware and software adjustments are safeguarded through maintenance logs, audit trails, and controlled access.

19.20. Ensure Information Availability

19.20.1. Protection against loss of information or service is ensured through scheduled back-ups, stable file server network architecture, secure storage of media, line filter, Uninterruptible Power Supply (UPS), and maintaining older versions of software as revisions are implemented.

19.21. Maintain Confidentiality

19.21.1. Data confidentiality is ensured through physical access controls, such as password protection or website access approval, when electronically transmitting data.

19.22. Data Reduction

19.22.1. The complexity of the data reduction depends on the analytical method and the number of discrete operations involved, e.g., extractions, dilutions, instrument readings, and concentrations. The analyst calculates the final results from the raw data or uses appropriate computer programs to assist in the calculation of final reportable values.

19.22.2. For manual data entry, e.g., General Chemistry, the data is reduced by the analyst and then verified by peer review once uploaded into LIMS. The review checklists are signed by both the analyst and reviewer to confirm the accuracy of the manual entry(s).

19.22.3. Manual integration of peaks will be documented and reviewed and the raw data will be flagged in accordance with the TestAmerica Corporate SOP CA-Q-S-002, Acceptable Manual Integration Practices.

19.22.4. Analytical results are reduced to appropriate concentration units specified by the analytical method, taking into account factors such as dilution, sample weight or volume, etc. Blank correction will be applied only when required by the method or per manufacturer's specification; otherwise, it must not be performed. Calculations are independently verified by appropriate laboratory staff. Calculations and data reduction steps for various methods are summarized in the respective analytical SOPs or program requirements.

19.22.5. All raw data must be retained. All criteria pertinent to the method must be recorded. The documentation is recorded at the time observations or calculations are made and must be signed or initialed/dated (month/day/year). The person who performed each task (if multiple people were involved) in the preparation and analysis must be easily identifiable in the documentation.

19.22.6. In general, analyte results are reported in milligrams per liter (mg/L) or micrograms per liter (µg/L) for liquids and milligrams per kilogram (mg/kg) or micrograms per kilogram (µg/kg) for solids. The units "mg/L" and "mg/kg" are the same as "parts per million (ppm)". The units "µg/L" and "µg/kg" are the same as "parts per billion (ppb)." For values greater than 10,000 mg/L, results may be reported in percent, i.e., 10,000 mg/l = 1%. Units appropriate for us are defined in each laboratory SOP.

19.22.7. For those methods that do not have an instrument printout or an instrumental output compatible with the LIMS System, the raw results and dilution factors are entered directly into LIMS by the analyst, and

the software calculates the final result for the analytical report. LIMS has a defined significant figure criterion for each analyte.

19.22.8. The laboratory strives to import data directly from instruments or calculation spreadsheets to ensure that the reported data are free from transcription and calculation errors. For those analyses with an instrumental output compatible with the LIMS, the raw results and dilution factors are transferred into LIMS electronically after reviewing the quantitation report, and removing unrequested or unconfirmed compounds. The analyst reviews what has been entered into LIMS to check for errors.

19.23. Logbook / Worksheet Use Guidelines

19.23.1. Logbooks and worksheets are filled out in 'real time' and have enough information on them to trace the events of the applicable analysis/task (e.g., calibrations, standards, analyst, sample ID, date, time on short holding time tests, temperatures when applicable, traceable calculations, etc.). Logbooks and worksheets can also be in electronic format.

19.23.2. Corrections are made following the procedures outlined in Section 12.

19.23.3. Logbooks are controlled by the QA Department. A record is maintained of all logbooks in the lab.

19.23.4. Unused portions of pages must be "Z"'d out, signed and dated.

19.23.5. Worksheets are created with the approval of the QA Department at the facility. The QA Department controls all worksheets following the procedures in Section 6.

19.24. Data Recording Procedures

19.24.1. To ensure data integrity, all documentation of data and records generated or used during the process of data generation must be performed in compliance with Section 3 of this document and Policy CA-Q-T-005, Laboratory Documentation.

19.25. Data Review and Verification Procedures

19.25.1. Data review procedures comprise a set of computerized and manual checks applied at appropriate levels of the measurement process. Data review begins with the reduction or processing of data and continues through verification of the data and the reporting of analytical results. Calculations are checked from the raw data to the final value prior to reporting results for each group of samples. Data reduction can be performed by the analyst who obtained the data or by another analyst. Data verification starts with the analyst who performs a 100% review of the data to ensure the work was done correctly the first time. Data verification continues with review by a second reviewer who verifies that

data reduction has been correctly performed and that the analytical results correspond to the data acquired and processed.

19.26. Data Reduction and Initial Verification

19.26.1. Data reduction and initial verification may be performed by more than one analyst depending upon the analytical method employed. The preparation and analytical data may be reviewed independently by different analysts. In these instances, each item may not be applicable to the subset of the data verified or an item may be applicable in both instances. It is the responsibility of the analyst to ensure that the verification of data in his or her area is complete. The data reduction and initial verification process must ensure that:

19.26.2. Sample preparation information is correct and complete including documentation of standard identification, solvent lot numbers, sample amounts, etc.

19.26.3. Analysis information is correct and complete including proper identification of analysis output (charts, chromatograms, mass spectra, etc.)

19.26.4. Analytical results are correct and complete including calculation or verification of instrument calibration, QC results, and qualitative and quantitative sample results with appropriate qualifiers

19.26.5. The appropriate SOPs have been followed and are identified in the project and/or laboratory records

19.26.6. Proper documentation procedures have been followed

19.26.7. All non-conformances have been documented

19.26.8. Special sample preparation and analytical requirements have been met.

19.26.9. The data generated have been reported with the appropriate number of significant figures as defined by the analytical method in the LIMS or otherwise specified by the client.

19.26.10. In general, data will be processed by an analyst in one of the following ways:

19.26.11. Manual computation of results directly on the data sheet or on calculation pages attached to the data sheets

19.26.12. Input of raw data for computer processing

19.27. Direct acquisition and processing of raw data by a computer.

19.27.1. If data are manually processed by an analyst, all steps in the computation must be provided including equations used and the source

of input parameters such as response factors (RFs), dilution factors, and calibration constants. If calculations are not performed directly on the data sheet, they may be attached to the data sheets.

19.27.2. Manual integrations are sometimes necessary to correct misintegrations by an automatic data system software program, but must only be performed when necessary. Further discussion of manual integrations and the required documentation is given in Policy CA-Q-S-002, Acceptable Manual Integration Practices.

19.27.3. For data that are input by an analyst and processed using a computer, a copy of the input must be kept and uniquely identified with the project number and other information as needed. The samples analyzed must be clearly identified.

19.27.4. If data are directly acquired from instrumentation or a test procedure and processed, or immediately entered into LIMS, the analyst must verify that the following are correct:

19.27.4.1. Project and sample numbers

19.27.4.2. Calibration constants and RFs

19.27.4.3. Units

19.27.4.4. Numerical values used for reporting limits.

19.27.5. Analysis-specific calculations for methods are provided in SOPs. In cases where computers perform the calculations, software must be validated or verified, as described in Section 6.0 of this document, before it is used to process data.

19.27.6. The data reduction is documented, signed and dated by the analyst completing the process. Initial verification of the data reduction by the same analyst is documented on a data review checklist, signed and dated by the analyst.

19.28. Data Verification

19.28.1. Following the completion of the initial verification by the analyst performing the data reduction, a systematic check of the data that has been fully reduced and checked through Level 1 review is performed by an experienced peer, group leader, or designee. This Level 2 check is performed to ensure that Level 1 review has been completed correctly and thoroughly. The second level reviewer examines the data signed by the analyst. Any exceptions noted by the analyst must be reviewed. Included in this review is an assessment of the acceptability of the data with respect to:

19.28.1.1. Adherence of the procedure used to the requested analytical method SOP

19.28.1.2. Correct interpretation of chromatograms, mass spectra, etc.

19.28.1.3. Correctness of numerical input when computer programs are used (checked randomly)

19.28.1.4. Correct identification and quantitation of constituents with appropriate qualifiers

19.28.1.5. Numerical correctness of calculations and formulas (checked randomly)

19.28.1.6. Acceptability of QC data (100% review)

19.28.1.7. Documentation that instruments were operating according to method specifications (calibrations, performance checks, etc.)

19.28.1.8. Documentation of dilution factors, standard concentrations, etc.

19.28.1.9. Sample holding time assessment.

19.28.2. This review also serves as verification that the process the analyst has followed is correct in regard to the following:

19.28.3. The analytical procedure follows the methods and client-specific instructions.

19.28.4. Nonconforming events have been addressed by corrective action as defined on a nonconformance memo

19.28.5. Valid interpretations have been made during the examination of the data and the review comments of the initial reviewer are correct

19.28.6. The package contains all of the necessary documentation for data review and report production and results are reported in a manner consistent with the method used for preparation of data reports.

19.28.7. The specific items covered in the second stage of data verification may vary according to the analytical method, but this review of the data must be documented by signing the same checklist.

19.29. Completeness Verification

19.29.1. A third-level review is performed by the project management staff. This review is required before results are submitted to clients. This review serves to verify the completeness of the data report and to ensure that project requirements are met for the analyses performed. The items to be reviewed are:

19.29.2. Analysis results are present for every sample in the analytical batch, reporting group, or sample delivery group (SDG)

19.29.3. Every parameter or target compound requested is reported with either a value or reporting limit

19.29.4. All nonconformances, including holding time violations and data evaluation statements that impact the data quality are accompanied by clearly expressed comments from the laboratory

19.29.5. The final report contains all the supporting documentation required by the project, and is in either the standard TestAmerica format or in the client-required format.

19.29.6. Implement checks to monitor the quality of laboratory results using correlation of results for different parameters of a sample (for example, does the TOC results justify the concentration of organic compounds found by GC/MS.)

19.29.7. A narrative to accompany the final report must be finalized by the PM. This narrative must include relevant comments collected during the earlier reviews.

19.29.8. The Quality Assurance Department performs data reviews per SOP CA-Q-S-004, Internal Auditing. For DoD work, 10% of all reports must undergo an internal data review.

19.30. Manual Integrations

19.30.1. Computerized data systems provide the analyst with the ability to re-integrate raw instrument data in order to optimize the interpretation of the data. Though manual integration of data is an invaluable tool for resolving variations in instrument performance and some sample matrix problems, when used improperly, this technique would make unacceptable data appear to meet quality control limits. Improper re-integrations lead to legally indefensible data, a poor reputation, or possible laboratory decertification. Because guidelines for re-integration of data are not provided in the methods, and most methods were written prior to widespread implementation of computerized data systems, the laboratory trains all analytical staff on proper manual integration techniques using TestAmerica's Corporate SOP (CA-Q-S-002).

19.30.2. The analyst must adjust baseline or the area of a peak in some situations, for example when two compounds are not adequately resolved, or when a peak shoulder needs to be separated from the peak of interest. The analyst must use professional judgment and common sense to determine when manual integrating is required. Analysts are encouraged to ask for assistance from a senior analyst or manager when in doubt.

19.30.3. Analysts must not increase or decrease peak areas for the sole purpose of achieving acceptable QC recoveries that would have otherwise been

unacceptable. The intentional recording or reporting of incorrect information (or the intentional omission of correct information) is against company principals and policy and is grounds for immediate termination.

19.30.4. Client samples, performance evaluation samples, and quality control samples are all treated equally when determining whether or not a peak area or baseline should be manually adjusted.

19.30.5. All manual integrations receive a second level review. Manual integrations must be indicated on an expanded scale “after” chromatograms such that the integration performed can be easily evaluated during data review. Expanded scale “before” chromatograms are also required for all manual integrations on QC parameters (calibrations, calibration verifications, laboratory control samples, internal standards, surrogates, etc.) unless the laboratory has another documented corporate-approved procedure in place that can demonstrate an active process for detection and deterrence of improper integration practices.

Figure 19-1. Example - Demonstration of Capability Documentation

GC Analyst Demonstration of Capability

TestAmerica Canton

Analyst:

DOC Run Date:

Preparation Method(s):

8151 Herbicide SOP: NC-GC-038	WI DRO SOP: NC-GC-013	8315 Formaldehyde SOP: NC-GC-035	WI GRO Prep/Analysis SOP: NC-GC-031	8082/608 PCBs SOP: NC-GC-007/NC-GC-038
8081/608 Pesticides SOP: NC-GC-038	8015 DRO SOP NC-GC-043	8015 GRO Prep/Analysis SOP: NC-GC-025	Aromatic Acids Analysis (solid and water), solid prep SOP: NC-GC-036	RSK-175 SOP: NC-GC-032
1630 MeHg Prep/Analysis SOP: NC-GC-039	8011 Prep/Analysis SOP: NC-GC-040			

Matrix: ? Water ? Solid

We, the undersigned, CERTIFY that:

1. The analyst identified above, using the cited test method with the specifications in the cited SOP, which is in use at the facility for the analysis of samples under the laboratory's Quality Assurance Plan, has completed the Demonstration of Capability (DOC).

2. The test method(s) was performed by the analyst identified on this certificate.

3. The data associated with the demonstration of capability are true, accurate, complete, and self-explanatory.

4. All raw data to reconstruct and validate these analyses have been retained at the facility.

5. The associated information is organized and available for review.

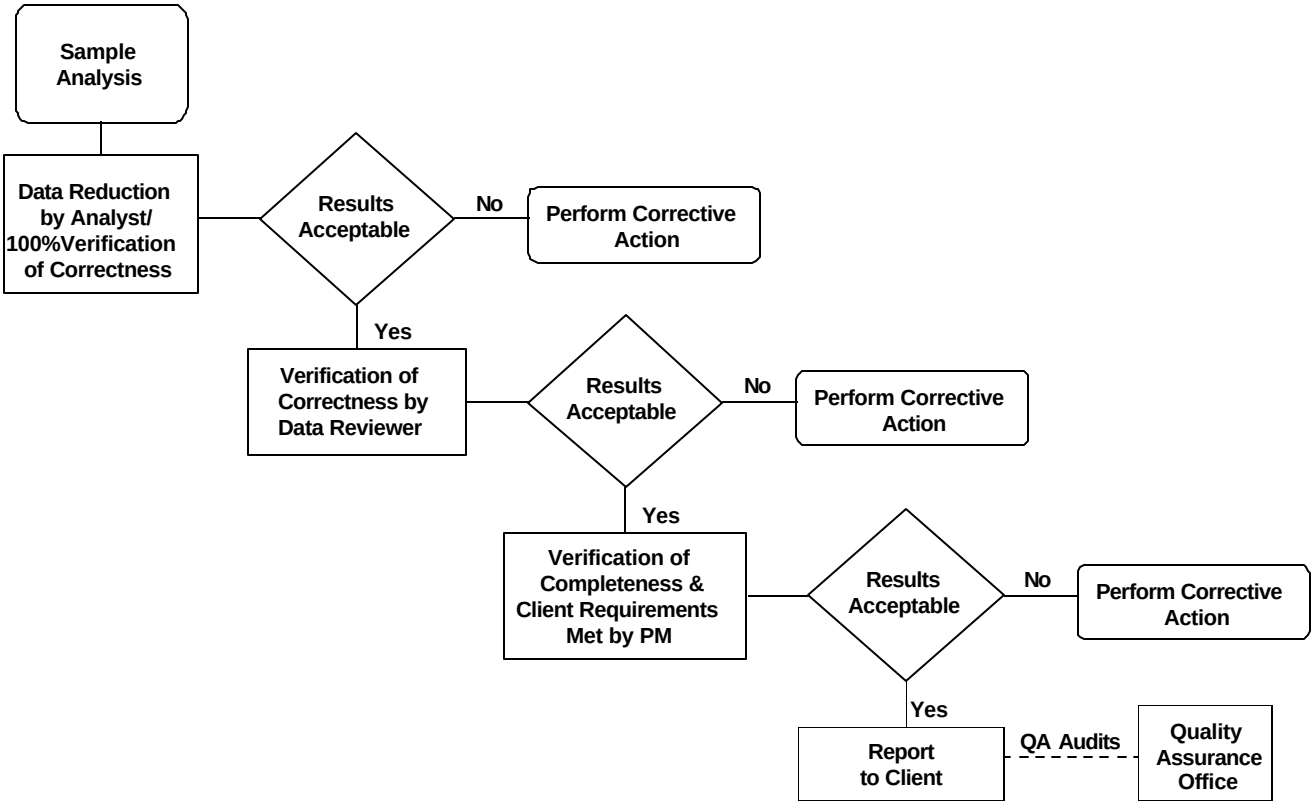
_____ _____ _____

Department Supervisor Signature Date

_____ _____ _____

Quality Assurance Officer Signature Date

Figure 19-2. Work Flow



20. EQUIPMENT AND CALIBRATIONS

20.1. The laboratory purchases technically advanced analytical instrumentation for sample analyses. Instrumentation is purchased on the basis of accuracy, dependability, efficiency, and sensitivity. Each laboratory is furnished with all items of sampling, preparation, analytical testing and measurement equipment necessary to correctly perform the tests for which the laboratory has capabilities. Each piece of equipment is capable of achieving the required accuracy and complies with specifications relevant to the method being performed. Before being placed into use, the equipment (including sampling equipment) is calibrated and checked to ensure that it meets its intended requirements. The calibration routines for analytical instruments establish the range of quantitation. Calibration procedures are specified in laboratory SOPs. A list of laboratory equipment and instrumentation is presented in Table 20-1.

20.2. Equipment is only operated by authorized and trained personnel. Manufacturers' instructions for equipment use are readily accessible to all appropriate laboratory personnel on the laboratory intranet.

20.3. Preventive Maintenance

20.3.1. The laboratory follows a well-defined maintenance program to ensure proper equipment operation and to prevent the failure of laboratory equipment or instrumentation during use. This program of preventive maintenance helps to avoid delays due to instrument failure.

20.3.2. Routine preventive maintenance procedures and frequency, such as lubrication, cleaning, and replacements, are performed according to the procedures outlined in the manufacturer's manual. Qualified personnel also perform maintenance when there is evidence of degradation of peak resolution, a shift in the calibration curve, loss of sensitivity, or failure to continually meet one of the quality control criteria.

20.3.3. Table 20-2 lists examples of scheduled routine maintenance. It is the responsibility of each Group Leader to ensure instrument maintenance logs are kept for all equipment in his/her department. Preventative maintenance procedures are also outlined in analytical SOPs or instrument manuals. (Note: For some equipment, the log used to monitor performance is also the maintenance log. Multiple pieces of equipment may share the same log as long as it is clear which instrument is associated with an entry.)

20.3.4. Instrument maintenance logs are controlled and are used to document instrument problems, instrument repair and maintenance activities. Maintenance logs must be kept for all major pieces of equipment. Instrument Maintenance Logbooks may also be used to specify instrument parameters.

20.3.5. Documentation must include all major maintenance activities such as contracted preventive maintenance and service, upgrades, and in-house

activities such as the replacement of electrical components, lamps, tubing, valves, columns, detectors, cleaning, and adjustments.

20.3.6. Each entry in the instrument log includes the Analyst's initials, date, a detailed description of the problem (or maintenance needed/scheduled), a detailed explanation of the solution or maintenance performed, and a verification that the equipment is functioning properly (state what was used to determine a return to control, e.g., CCV run on 'date' was acceptable, or instrument recalibrated on 'date' with acceptable verification, etc.) must also be documented in the instrument records. A return to service date must be documented in the logbook.

20.3.7. When maintenance or repair is performed by an outside agency, service receipts detailing the service performed can be affixed into the logbooks adjacent to pages describing the maintenance performed. This stapled-in page must be signed across the page entered and the logbook, so it is clear that a page is missing if only half a signature is found in the logbook. At a minimum, if an instrument is sent out for service or transferred to another facility it must be recalibrated upon installation and the laboratory MDL must be verified (using an MDLV) prior to return to laboratory operation.

20.4. Instrument Repair

20.4.1. If an instrument requires repair (subjected to overloading or mishandling, gives suspect results, or otherwise has been shown to be defective or outside of specified limits) it must be taken out of operation and tagged as out of service or otherwise isolated until such a time as the repairs have been made and the instrument can be demonstrated as operational by calibration and/or verification or other test to demonstrate acceptable performance. The laboratory must examine whether this defect had any effect on previous analyses.

20.5. Equipment Malfunction

20.5.1. In the event of equipment malfunction that cannot be resolved, service shall be obtained from the instrument vendor, manufacturer, or qualified service technician, if such a service can be tendered. If on-site service is unavailable, arrangements shall be made to have the instrument shipped back to the manufacturer for repair. Backup instruments, which have been approved, for the analysis shall perform the analysis normally carried out by the malfunctioning instrument. If the backup is not available and the analysis cannot be carried out within the needed timeframe, the samples must be subcontracted.

20.6. Instrument Transfer or Send-Out

20.6.1. If an instrument is sent out for service or transferred to another facility, it must be recalibrated and verified (including new initial MDL study) prior to return to lab operations.

20.7. Support Equipment

20.7.1. This section applies to all devices that may not be the actual test instrument, but are necessary to support laboratory operations. These include but are not limited to balances, ovens, refrigerators, freezers, incubators, water baths, field sampling devices, temperature measuring devices, dispensing devices, if quantitative results are dependent on their accuracy, as in standard preparation and dispensing or dilution into a specified volume. All raw data records associated with the support equipment are retained to document method performance.

20.8. Weights and Balances

20.8.1. The accuracy of the balances used in the laboratory is checked every working day, before use. All balances are placed on stable counter tops.

20.8.2. Each balance is checked prior to initial serviceable use with at least two certified ASTM Type 1 weights spanning its range of use (weights that have been calibrated to ASTM Type 1 weights may also be used for daily verification). ASTM Type 1 weights used only for calibration of other weights (and no other purpose) are inspected for corrosion, damage or nicks at least annually and if no damage is observed, they are calibrated at least every five years by an outside calibration laboratory. Any weights (including ASTM Type 1) used for daily balance checks or other purposes are recalibrated/recertified annually to NIST standards (this may be done internally if laboratory maintains “calibration only” ASTM Type 1 weights).

20.8.3. All balances are serviced annually by a qualified service representative, who supplies the laboratory with a certificate that identifies traceability of the calibration to the NIST standards and the error term inherent in the calibration.

20.8.4. All of this information is recorded in logs, and the recalibration/recertification certificates are kept on file. Reference SOP NC-QA-015, Equipment Monitoring and Thermometer Calibration. A list of balances is in Table 21.2.

20.9. pH, Conductivity, and Turbidity Meters

20.9.1. The pH meters used in the laboratory are accurate to + 0.1 pH units, and have a scale readability of at least 0.05 pH units. The meters automatically compensate for the temperature, and are calibrated with at least two working range buffer solutions before each use.

20.9.2. Conductivity meters are also calibrated before each use with a known standard to demonstrate that the meters do not exceed an error of 1% or one umhos/cm.

20.9.3. Turbidity meters are also calibrated before each use. All of this information is documented in logs.

20.9.4. Consult pH, Conductivity, and Turbidity SOPs for further information.

20.10. Thermometers

20.10.1. All thermometers are calibrated on an annual basis with a NIST-traceable thermometer at temperatures bracketing the range of use. IR thermometers, digital probes, thermocouples, refrigerator thermometers (not NIST-Traceable), and freezer thermometers (not NIST –Traceable) are calibrated quarterly. IR Thermometers should be calibrated over the full range of use, including ambient, iced (4 degrees) and frozen (0 to -5 degrees), per the Drinking Water Manual.

20.10.2. The mercury/digital NIST thermometer is recalibrated every two to five years (unless thermometer has been exposed to temperature extremes or apparent separation of internal liquid) by an approved outside service and the provided certificate of traceability is kept on file. The NIST thermometer(s) have increments of 1 degree (0.5 degree or less increments are required for drinking water microbiological laboratories), and have ranges applicable to method and certification requirements. The NIST traceable thermometer is used for no other purpose than to calibrate other thermometers.

20.10.3. All of this information is documented in logsheets. Monitoring of method-specific temperatures, including incubators, heating blocks, water baths, and ovens, is documented in method-specific logsheets. More information on this subject can be found in SOP NC-QA-015, Equipment Monitoring and Thermometer Calibration.

20.11. Refrigerators/Freezer Units, Waterbaths, Ovens and Incubators

20.11.1. The temperatures of all refrigerator units and freezers used for sample and standard storage are monitored each working day (seven days a week for DOD labs).

20.11.2. Ovens, waterbaths and incubators are monitored on days of use.

20.11.3. All of this equipment has a unique identification number, and is assigned a unique thermometer for monitoring.

20.11.4. Sample storage refrigerator temperatures are kept between or 4 + 2oC.

20.11.5. Specific temperature settings/ranges for other refrigerators, ovens waterbaths, and incubators can be found in method specific SOPs.

20.11.6. All of this information is documented in Daily Temperature Logsheets posted on each unit or saved electronically if an electronic monitoring system (such as Temp Guard) is used.

20.12. Autopipettors, Dilutors, and Syringes

20.12.1. Mechanical volumetric dispensing devices including burettes (except Class A glassware and glass microliter syringes) are given unique identification numbers and the delivery volumes are verified gravimetrically, at a minimum, on a quarterly basis.

20.12.2. Micro-syringes are purchased from Hamilton Company. Each syringe is traceable to NIST. The laboratory keeps on file an "Accuracy and Precision Statement of Conformance" from Hamilton attesting established accuracy.

20.12.3. The laboratory maintains a sufficient inventory of autopipettors, and dilutors of differing capacities that fulfill all method requirements.

20.12.4. These devices are given unique identification numbers, and the delivery volumes are verified gravimetrically, at a minimum, on a quarterly basis.

20.12.5. Any device not regularly verified cannot be used for any quantitative measurements.

20.13. Field Sampling Devices (ISCO Autosamplers)

20.13.1. Each autosampler (ISCO) is assigned a unique identification number in order to keep track of the calibration. This number is recorded on the sampling documentation in a logbook.

20.13.2. The autosampler is calibrated semi-annually by setting the sample volume to 100ml and recording the volume received. The results are filed in a logbook/binder. The autosampler is programmed to run three cycles, and each of the three cycles is measured into a beaker to verify 100 ml are received.

20.13.3. If the RSD (Relative Standard Deviation) between the three cycles is greater than 20%, the procedure is repeated. If the result is still greater than 20%, the following options may be employed:

20.13.3.1. The unit is taken out of service.

20.13.3.2. The unit is used to pull composite samples only over a 24-hour period.

20.13.3.3. The results of this check are kept in a logbook/binder.

20.14. Instrument Calibrations

20.14.1. Calibration of analytical instrumentation is essential to the production of quality data. Strict calibration procedures are followed for each method. These procedures are designed to determine and document the method detection limits, the working range of the analytical instrumentation and any fluctuations that may occur from day to day.

20.14.2. Sufficient raw data records are retained to allow an outside party to reconstruct all facets of the initial calibration. Records contain, but are not limited to, the following: calibration date, method, instrument, analyst(s) initials or signatures, analysis date, analytes, concentration, response, type of calibration (Avg RF, curve, or other calculations that may be used to reduce instrument responses to concentration.)

20.14.3. Sample results must be quantitated from the initial calibration and may not be quantitated from any continuing instrument calibration verification unless otherwise required by regulation, method, or program.

20.14.4. If the initial calibration results are outside of the acceptance criteria, action is performed and any affected samples are re-analyzed, if possible. If re-analysis is not possible, any data associated with an unacceptable initial calibration must be reported with appropriate data qualifiers (refer to Section 12). All sample analyses reported for Ohio VAP certified data must be associated with a valid calibration.

Note: Instruments are calibrated initially and as needed after that and at least annually.

20.15. Calibration Standards

20.15.1. Calibration standards are prepared using the procedures indicated in the Reagents and Standards section of the determinative method SOP. If a reference method does not specify the number of calibration standards, a minimum of three calibration points (exception being ICP and ICP/MS methods) will be used.

20.15.2. Standards for instrument calibration are obtained from a variety of sources. All standards are traceable to national or international standards of measurement, or to national or international standard reference materials.

20.15.3. The lowest concentration calibration standard that is analyzed during an initial calibration must be at or below the stated reporting limit for the method based on the final volume of extract (or sample).

20.15.4. The other concentrations define the working range of the instrument/method or correspond to the expected range of concentrations found in actual samples that are also within the working range of the instrument/method. Results of samples not bracketed by initial instrument calibration standards (within calibration range to at least the same number of significant figures used to report the data) must be reported as having less certainty, e.g., defined qualifiers or flags (additional information may be included in the case narrative). The exception to these rules is ICP methods or other methods where the referenced method does not specify two or more standards.

20.15.5. All initial calibrations are verified with a standard obtained from a second source and traceable to a national standard, when available (or

vendor certified different lot if a second source is not available). For unique situations, such as air analysis where no other source or lot is available, a standard made by a different analyst would be considered a second source. This verification occurs immediately after the calibration curve has been analyzed, and before the analysis of any samples.

20.16. Calibration Verification

20.16.1. The calibration relationship established during the initial calibration must be verified initially (with a second source ICV) and at least daily (with a CCV) as specified in the laboratory method SOPs in accordance with the referenced analytical methods and and in the 2009 TNI Standard. The process of calibration verification applies to both external standard and internal standard calibration techniques, as well as to linear and non-linear calibration models.

20.16.2. Note: The process of calibration verification referred to is fundamentally different from the approach called "calibration" in some methods. As described in those methods, the calibration factors or response factors calculated during calibration are used to update the calibration factors or response factors used for sample quantitation. This approach, while employed in other EPA programs, amounts to a daily single-point calibration.

20.16.3. All target analytes and surrogates, including those reported as non-detects, must be included in periodic calibration verifications for purposes of retention time confirmation and to demonstrate that calibration verification criteria are being met, i.e., RPD, per 2009 TNI Standard EL-V1M4 Section 1.7.2.

20.16.4. All samples must be bracketed by periodic analyses of standards that meet the QC acceptance criteria (e.g., calibration and retention time). The frequency is found in the determinative methods or SOPs.

Note: If an internal standard calibration is being used (e.g., most GCMS methods), then bracketing standards are not required. Only daily verifications are needed. The results from these verification standards must meet the calibration verification criteria and the retention time criteria (if applicable).

20.16.5. Generally, the initial calibrations must be verified at the beginning of each 12-hour analytical shift during which samples are analyzed. (Some methods may specify more or less frequent verifications). The 12-hour analytical shift begins with the injection of the calibration verification standard (or the MS tuning standard in MS methods). The shift ends after the completion of the analysis of the last sample or standard that can be injected within 12 hours of the beginning of the shift.

20.16.6. A continuing calibration verification (CCV) standard must be repeated at the beginning and, for methods that have quantitation by external

calibration models, at the end of each analytical batch. Some methods have more frequent CCV requirements (see specific SOPs). Most Inorganic methods require the CCV to be analyzed after ever 10 samples or injections including matrix or batch QC samples.

Note: If an internal standard calibration is being used, then bracketing standards are not required. Only daily verifications are needed. The results from these verification standards must meet the calibration verification criteria and the retention time criteria (if applicable).

20.16.7. If the results of a CCV are outside the established acceptance criteria and analysis of a second consecutive (and immediate) CCV fails to produce results within acceptance criteria, corrective action shall be performed. Once corrective actions have been completed and documented, the laboratory shall demonstrate acceptable instrument / method performance by analyzing two consecutive CCVs, or a new initial instrument calibration shall be performed.

20.16.8. Sample analyses and reporting of data may not occur or continue until the analytical system is calibrated or calibration verified. However, data associated with unacceptable calibration verification may be fully useable under the following special conditions and reported based upon discussion and approval of the client.

20.16.9. When acceptance criteria for the CCV are exceeded high (i.e., high bias) and the associated samples within the batch are non-detects, then those non-detects may be reported with a footnote or case narrative explaining the high bias. Otherwise, the samples affected by the unacceptable CCV shall be re-analyzed after a new calibration curve has been established, evaluated, and accepted; or

20.16.10. When the acceptance criteria for the CCV are exceeded low (i.e., low bias), those sample results may be reported if they exceed a maximum regulatory limit/decision level. Otherwise, the samples affected by the unacceptable CCV shall be re-analyzed after a new calibration curve has been established, evaluated, and accepted.

20.16.11. Samples reported by the two conditions identified above will be appropriately flagged.

20.17. Verification of Linear Calibrations

20.17.1. Calibration verification for linear calibrations involves the calculation of the percent drift or the percent difference of the instrument response between the initial calibration and each subsequent analysis of the verification standard. (These calculations are available in the laboratory method SOPs.) Verification standards are evaluated based on the % Difference from the average CF or RF of the initial calibration or based on % Drift or % Recovery if a linear or quadratic curve is used.

20.17.2. Regardless of whether a linear or non-linear calibration model is used, if initial verification criterion is not met, then no sample analyses may take place until the calibration has been verified or a new initial calibration is performed that meets the specifications listed in the method SOPs. If the calibration cannot be verified after the analysis of a single verification standard, then adjust the instrument operating conditions and/or perform instrument maintenance, and analyze another aliquot of the verification standard. If the calibration cannot be verified with the second standard, then a new initial calibration is performed.

20.17.3. When the acceptance criteria for the calibration verification are exceeded high, i.e., high bias, and there are associated samples that are non-detects, then those non-detects may be reported. Otherwise, the samples affected by the unacceptable calibration verification shall be reanalyzed after a new calibration curve has been established, evaluated and accepted.

20.17.4. When the acceptance criteria for the calibration verification are exceeded low, i.e., low bias, those sample results may be reported if they exceed a maximum regulatory limit/decision level. Otherwise, the samples affected by the unacceptable verification shall be reanalyzed after a new calibration curve has been established, evaluated and accepted. For Ohio VAP samples, results may not be reported when calibration verifications are exceeded low.

20.18. Tentatively Identified Compounds (TICs) – GC/MS Analysis

20.18.1. For samples containing components not associated with the calibration standards, a library search may be made for the purpose of tentative identification. The necessity to perform this type of identification will be determined by the purpose of the analyses being conducted. Data system library search routines should not use normalization routines that would misrepresent the library or unknown spectra when compared to each other. TICs cannot be reported as “VAP certified” data for Ohio VAP projects.

Note: If the TIC compound is not part of the client target analyte list but is calibrated by the laboratory and is both qualitatively and/or quantitatively identifiable, it should not be reported as a TIC. If the compound is reported on the same form as true TICs, it should be qualified and/or narrated that the reported compound is qualitatively and quantitatively (if verification in control) reported compared to a known standard that is in control (where applicable).

20.18.2. For example, the RCRA permit or waste delisting requirements may require the reporting of non-target analytes. Only after visual comparison of sample spectra with the nearest library searches may the analyst assign a tentative identification.

20.19. GC/MS Tuning

20.19.1. Prior to any GCMS analytical sequence, including calibration, the instrument parameters for the tune and subsequent sample analyses within that sequence must be set.

20.19.2. Prior to tuning/auto-tuning the mass spec, the parameters may be adjusted within the specifications set by the manufacturer or the analytical method. These generally don't need any adjustment but it may be required based on the current instrument performance. If the tune verification does not pass it may be necessary to clean the source or perform additional maintenance. Any maintenance is documented in the maintenance log.

Table 20-1. Laboratory Equipment and Instrumentation

Instrument Type	Manufacturer/ID	Model/Serial Number	Year into Service
GC/MS Volatiles Instrument	Hewlett-Packard (UX2)	5971A-5890, S/N US00029070 (screening)	1992
	Hewlett-Packard (HP6)	5973-6890, S/N US00005571 (screening)	1998
	Hewlett-Packard (UX7)	5973-6890, S/N US00010937 (screening)	1998
	Hewlett-Packard (UX8)	5973-6890, S/N US00027773	1999
	Hewlett-Packard (UX9)	5973-6890, S/N US00028329	2000
	Hewlett-Packard (UX10)	5973-6890, S/N US00032072	2000
	Agilent (UX11)	5973-6890, S/N US00038093	2000
	Agilent (UX12)	5973-6890, S/N US10202133	2002
	Agilent (UX14)	5973-6890, S/N CN10340027	2003
	Agilent (UX15)	5973-6890, S/N CN10515062	2005
	Agilent (UX16)	5975-6890, S/N CN10539065	2005
	Agilent (UX17)	5975-7890, S/N US10831043	2012
	Agilent (UX18)	5973-6890, S/N US00020913	2013
GC/MS Volatiles Autosampler	OI Analytical (UX2)	4552, S/N 12019(screening)	1999
	OI Analytical (HP6)	4552, S/N 12258 , 12151(screening)	1998
	OI Analytical (UX7)	4552, S/N 13154 (screening)	1998
	OI Analytical (UX8)	4552, S/N 13089	1999
	OI Analytical (UX9)	4552, S/N 13667	2000
	OI Analytical (UX10)	4552, S/N 12058	2000
	OI Analytical (UX11)	4552, S/N 13408	2000
	OI Analytical (UX12)	4552, S/N 12075	2002
	OI Analytical (UX14)	4552, S/N 14092	2003
	OI Analytical (UX15)	4552, S/N 14368	2005
	OI Analytical (UX16)	4552, S/N 14519	2005
	OI Analytical (UX17)	4552, S/N US12160002	2012

Instrument Type	Manufacturer/ID	Model/Serial Number	Year into Service
	OI Analytical (UX18)	4552, S/N 14519	2013
GC/MS Volatiles Purge and Trap	OI Analytical (UX2)	4560, S/N N251460461 (screening)	1999
	OI Analytical (HP6)	Encon (screening)	1998
	OI Analytical (UX7)	4560, S/N K822460889 (screening)	2004
	OI Analytical (UX8)	4560, S/N B444466152P	2004
	OI Analytical (UX9)	4560, S/N M946460832	2000
	OI Analytical (UX10)	4660, S/N BETA6	2003
	OI Analytical (UX11)	4560 S/N K811460270	2000
	OI Analytical (UX12)	4560, S/N NM041460393	2002
	OI Analytical (UX14)	4660 S/N D829466914P	2008
	OI Analytical (UX15)	4660, S/N C511466149P	2005
	OI Analytical (UX16)	4660, S/N D539446261P	2005
	OI Analytical (UX17)	4660, S/N H224466292P	2012
	OI Analytical (UX18)	4560, S/N N213460621	2013
GC/MS Semivolatiles Instrument	Hewlett-Packard HP7	5973-6890, S/N US71190756-US00009247	1998
	Hewlett-Packard HP9	5973-6890, S/N US91422379-US72020889	2000
	Agilent HP10	5973-6890, S/N US33220074-CN10340002	2003
	Agilent A4AG2	5975C-7890, S/N US71235692-CN10721110	2007
GC Volatiles (GCV) Analyzer	Agilent (A)	6890 FID, S/N US10402056	2004
	Hewlett-Packard (O)	6890 PID/FID, S/N US00007206	1997
	Hewlett-Packard (Y)	6890N PID/FID, S/N US10337062	2003
	Agilent (Z)	6890 EPC & PDD/FID, S/N 10205072	2000
GCV Autosampler	OI Analytical (O)	Archon, S/N 13196	2000
	OI Analytical (Y)	4552, S/N 14045	1998
	EST (A)	Archer 8100 SN 14280	2013
	Agilent (Z)	7694 S/N IT21111663	2000
GCV Purge and Trap	OI Analytical (O)	4560 S/N N336460661	2000
	Tekmar (A)	3000 S/N 93104002	1998
	Tekmar (Y)	3000 S/N 97155002	1993
GC Semivolatiles (GCS) MeHg Analyzer	Agilent N	7890 Atomic Fluorescence, S/N CN10820009 (MeHg)	2008
	Tekran (MHg)	2700 S/N 025	
GCS MeHg Autosampler	Tekran (MHg)	AIM3300 S/N 5143A 26273	
	EST (N)	Centurion (MeHg) S/N CENT249041408	2008
	Tekmar (N)	Stratum (MeHg) S/N US08141001	2008
	Tekmar (NOT IN USE)	Stratum (MeHg) S/N US08140004	2008
GCS MeHg Detector	PS Analytical	Model 10.750 (MeHg)	2008

Instrument Type	Manufacturer/ID	Model/Serial Number	Year into Service
GCS Instruments	Hewlett-Packard (P1)	6890 EPC & Dual ECD Y-Splitter S/N US00023208	1998
	Hewlett-Packard (P2)	6890 EPC & Dual ECD Y-Splitter S/N US00023512	1998
	Hewlett-Packard (P3)	6890 EPC & Dual ECD Y-Splitter S/N US00023674	1998
	Hewlett-Packard (P4)	6890 EPC & Dual ECD Y-Splitter S/N US00029531	1999
	Hewlett-Packard (P5)	6890 EPC & Dual ECD S/N US00029508	2010
	Hewlett-Packard (P6)	6890 EPC & Dual FID S/N US00032848	2000
	Agilent (P9)	6890N EPC & Dual ECD Y-Splitter S/N US10205045	2005
	Agilent (P10)	6890 EPC & Dual ECD Y-Splitter S/N US10151110	1999
	Agilent (P11)	6890N EPC & Dual ECD Y-Splitter S/N CN10517088	2004
	Agilent (P12)	6890N EPC & Dual ECD Y-Splitter S/N CN10512025	2005
	Agilent (P13)	6890N EPC & Dual ECD Y-Splitter S/N CN10435032	2004
	Agilent (P14)	7890 EPC & Dual FID S/N CN 10281044	2010
	Agilent (P15)	6890N EPC & Dual ECD Y-Splitter S/N CN10427010	2012
GCS HPLC	Hewlett-Packard (L2)	HPLC 1100, S/N US82404153	1998
Extractions Sonicator	Misonix	3000 (self-tuning), S/N R1044	2005
	Fisher	Ultrasonic Processor FB-705 S/N 80587G-14	2014
Extractions pH Meter	Mettler Toledo	SevenEasy pH (self-calibrating) S/N 1228295055	2008
	Denver Instrument (spare)	UB-5 S/N UB-5093011	2004
Metals ICP	Thermo (I12)	ICAP 6500 Duo Trace Analyzer, S/N ICP 20101711	2014
	Thermo (I9)	ICAP 6500 Duo Trace Analyzer, S/N ICP 20102403	2010
Metals ICP/MS	Thermo (I11)	Series 2, S/N 01952C	2013
	Agilent (I10)	7700x S/N JP12452145	2013
Metals Mercury	Leeman (CVAA) (H1)	PS200 II, S/N HG9031	1999
	Leeman (CVAA) (H4)	Hydra AA , S/N 6011	2006
Metals Low Level Mercury	Leeman (CVAF) (H6)	Hydra AF Gold+,Install # 64264	2005
	Leeman (CVAF) (H7)	Hydra AF Gold, Install #64547	2011
WC Autotitrator	Man-Tech (Steve)	PC – Titrate, S/N MS-9K8-217	2001
WC Block Digester	Andrews (Moe)	110-40-EZ	1999

Instrument Type	Manufacturer/ID	Model/Serial Number	Year into Service
	Andrews (Larry)	110-40-PA	1999
	Andrews (Curly)	110-40-PA	1999
	Lachat (Carol)	BD-46 TKN, S/N 00000993	2010
	Lachat (Mike)	BD-46, S/N 1800-910	2014
WC BOD	Mantech (Bugsy)	BOD, S/N MT-113-207	2014
WC Conductivity	ManTech (Arnie)	4310, S/N 1613	1989
WC Cyanide	LabCrest MidiDist	PRG-2520-BL, S/N 1000-99-01	1999
WC Discrete Analyzer	Kone (Barney)	Konelab 200, Z1718383	2001
	Kone (Sauron)	Konelab 250, A2120021	2005
	Systea (Maggie)	EasyChem Plus, S/N 07004	2013
WC Dissolved Oxygen Meter	YSI	YSI 5100, 13D 100737	2014
WC Flashpoint	Herzog (Whitey)	HFP 339, S/N 073390084	2007
WC Ion Chromatograph	Dionex (Cecilia)	ICS 1500, S/N 03100737	2014
	Dionex (Simon)	DX-120, S/N 98110093	1999
	Dionex (Veronica)	ICS 2100, S/N 12031443	2012
WC pH Meter	Orion pH Meter (Randolph)	Star A211, S/N X02404	2012
	Orion (Ammonia ISE) (Dave)	520A, S/N 48029	1996
WC TOC	OI Analytical (Sparky)	1010 TOC Analyzer, S/N K503710931	2005
WC EOX	Thermo Electron (Brian)	1200, S/N 2005.0234	2005
WC Turbidimeter	HF Scientific (Jack)	Micro 100, S/N 200705143	2001
WC UV/VIS	Genesys (Bert)	Spectronic 20, S/N 3SGL078016	1998
	Genesys (Ernie)	Spectronic 20, S/N 3SGL226006 (Model 4001/4)	2008
WC Sulfide	Westco EasyDist		2008

Table 20-2. Schedule of Routine Maintenance

(Refer to manufacturer's instructions for each instrument to identify and perform maintenance operations. Refer to the analytical SOP for frequency and criteria)

20.20. Instrument Maintenance Schedule

ION CHROMATOGRAPH

As Needed	Daily	Weekly	Monthly
Clean micro-membrane suppressor when decreases in sensitivity are observed.	Check plumbing/leaks	Check pump heads for leaks	Check all air and liquid lines for discoloration and crimping, if indicated.
Check fuses when power problems occur.	Check gases	Check filter (inlet)	Check/change bed supports guard and analytical columns, if indicated.
Reactivate or change column when peak shape and resolution deteriorate or when retention time shortening indicates that exchange sites have become deactivated.	Check pump pressure		
De-gas pump head when flow is erratic.	Check conductivity meter		

HIGH PRESSURE LIQUID CHROMATOGRAPH

Daily	As Needed
Check level of solution in reservoirs. If adding, verify that solvent is from the same source. If changing, rinse gas and delivery lines to prevent contamination of the new solvent.	Replace columns when peak shape and resolution indicate that chromatographic performance of column is below method requirements.
Check gas supply.	Oil autosampler slides when sample does not advance.
Flush with an appropriate solvent to remove all bubbles.	Rinse flow cell with 1N nitric acid if sensitivity low.
Pre-filter all samples.	Change pump seals when flow becomes inconsistent.
	Repack front end of column Back-flush column.

ICP AND ICP/MS

Daily	Monthly or As Needed	Semi-Annually	Annually
Check vacuum pump gage. (<10 millitorr)	Clean plasma torch assembly to remove accumulated deposits	Change vacuum pump oil	Notify manufacturer service engineer for scheduled preventive maintenance service
Check cooling water supply system is full and drain bottle is not full. Also drain tubing is clear, tight fitting, and has few bends.	Clean nebulizer and drain chamber; keep free flowing to maintain optimum performance	Replace coolant water filter (may require more or less frequently depending on quality of water)	
Check nebulizer is not clogged	Clean filters on back of power unit to remove dust		
Check capillary tubing is clean and in good condition	Replace when needed: - peristaltic pump tubing - sample capillary tubing - autosampler sipper probe		
Check peristaltic pump windings are secure	- Check yttrium position - Check O-rings - Clean/lubricate pump rollers		
Check high voltage switch is on			
Check torch, glassware, aerosol injector tube, and bonnet are clean			

CVAS AND CVAFS

Daily	As Needed	Annually
Change drying tube	Change pump tubing	Change Hg lamp
Check pump tubing/drain tubing	Check/change Hg lamp	
Check gas pressure	Clean optical cell	
Check aperture reading Check tubing	Lubricate pump	

GAS CHROMATOGRAPH

Daily *	As Needed
Check for sufficient supply of carrier and detector gases. Check for correct column flow and/or inlet pressures.	Replace front portion of column packing or break off front portion of capillary columns. Replace column if this fails to restore column performance, or when column performance (e.g., peak tailing, poor resolution, high backgrounds, etc.) indicates it is required. Quarterly FID: clean detector, only as needed—not quarterly/or semi-annually.
Check temperatures of injectors and detectors. Verify temperature programs by RT shift.	Change glass wool plug in injection port and/or replace injection port liner when front portion of column packing is changed or front portion of capillary column is removed.
Clean injector port weekly for TPH for 8015B, when breakdown fails; otherwise, when RT shift or bad samples run.	Annually FID: replace flame tip, only as needed. Only as needed: ECD--detector cleaning and re-foiling, whenever loss of sensitivity, erratic response, or failing resolution is observed
Check baseline level during analysis of run—not maintenance.	Perform gas purity check (if high baseline indicates that impure carrier gas may be in use).
Watched weekly: check reactor temperature of electrolytic conductivity detector. Inspect chromatogram to verify symmetrical peak shape and adequate resolution between closely eluting peaks, when analyzing pesticides; part of analysis—not maintenance. Clip column leader when chromatography looks bad—not daily.	Replace or repair flow controller if constant gas flow cannot be maintained. Replace fuse. Reactivate external carrier gas dryers. Detectors: clean when baseline indicates contamination or when response is low. FID: clean/replace jet, replace ignitor. ECD: follow manufacturer's suggested maintenance schedule. Reactivate flow controller filter dryers when presence of moisture is suspected. HP 7673 Autosampler: replace syringe, fill wash bottle, dispose of waste bottle contents.

*No daily maintenance done on any instrument/method. Weekly change IPL on TPH instrument. Everything else is on an "as needed" basis.

MASS SPECTROMETER

Daily	Weekly	As Needed	Quarterly	Annually
Check for sufficient gas supply. Check for correct column flow and/or inlet pressure.	Check mass calibration (PFTBA or FC-43)	Check level of oil in mechanical pumps and diffusion pump if vacuum is insufficient. Add oil if needed between maintenance.	Check ion source and analyzer (clean, replace parts as needed)	Replace the exhaust filters on the mechanical rough pump every 1-2 years.
Check temperatures of injector, detector. Verify temperature programs.		Replace electron multiplier when the tuning voltage approaches the maximum and/or when sensitivity falls below required levels.	Check vacuum, relays, gas pressures and flows	
Check inlets, septa		Clean Source, including all ceramics and lenses - the source cleaning is indicated by a variety of symptoms including inability of the analyst to tune the instrument to specifications, poor response, and high background contamination.	Change oil in the mechanical rough pump.	
Check baseline level		Repair/replace jet separator.		
Check values of lens voltages, electron multiplier, and relative abundance and mass assignments of the calibration compounds.		Replace filaments when both filaments burn out or performance indicates need for replacement.		

ANALYTICAL/TOP LOADING BALANCES

Daily	Annually
Check using Class 1-verified weights once daily or before use Clean pan and weighing compartment	Manufacturer cleaning and calibration

REFRIGERATORS/WALK-IN COOLERS

Daily	As Needed
Temperatures checked and logged	Refrigerant system and electronics serviced

OVENS

Daily	As Needed
Temperatures checked and logged	Electronics serviced

SPECIFIC DIGITAL ION ANALYZER

Daily	As Needed
Daily when used: Calibrate with check standards Inspect electrode daily, clean as needed Inspect electrode proper levels of filling solutions daily; fill as needed Clean probe after each use	Electronics serviced

TURBIDIMETER

Daily	Monthly	As Needed
Daily when used: Adjust linearity on varying levels of NTU standards. Standardize with NTU standards Inspect cells	Clean instrument housing	Electronics serviced

DISSOLVED OXYGEN METER

Daily	As Needed
Daily when used: Calibrate with saturated air Check probe membrane for deterioration Clean and replace membrane with HCl solution	Electronics serviced Clean and replace membrane with HCl solution

CONDUCTANCE METER

Daily	As Needed
Daily when used: Check probe and cables Inspect conductivity cell	Electronics serviced

CHEMICAL OXYGEN DEMAND (COD) REACTOR 1

Daily	As Needed
Daily when used: Calibrate with check standards	Electronics serviced

SPECTROPHOTOMETER

As Needed	Daily	Monthly	Annually
Dust the lamp and front of the front lens	Check the zero % adjustment	Clean windows	Check instrument manual
	Clean sample compartment		Perform wavelength calibration
	Clean cuvettes		Replace lamp annually or when erratic response is observed
			Clean and align optics

pH METER

As Needed	Daily
Clean electrode	Inspect electrode. Verify electrodes are properly connected and filled
Refill reference electrode	Inspect electrode proper levels of filling solutions. Make sure electrode is stored in buffer

TOTAL ORGANIC CARBON ANALYZER

Daily	As Needed	Weekly	Monthly
Check: Oxygen supply Persulfate supply Acid supply Carrier gas flow rate (~ 150 cc/min) IR millivolts for stability (after 30 min. warm-up) Reagent reservoirs	Check injection port septum after 50-200 runs Tube end-fitting connections after 100 hours or use Indicating drying tube NDIR zero, after 100 hours of use Sample pump, after 2000 hours for use Digestion vessel/condensation chamber, after 2000 hours of use Permeation tube, after 2000 hours of use NDIR cell, after 2000 hours of use Change pump tubing	Check liquid-flow-rate-pump-tubing conditions on autosampler Check injection port septum	Clean digestion vessel Clean condenser column Do the leak test

Digestion Block

Annually
Check temperature with NIST thermometer

Flash Point Tester

Daily
Check tubing Clean sample cup each use
Check gas
Clean flash assembly
Check stirrer

Table 20-3. Preventive Maintenance Procedures

(Note: Refer to the analytical SOP for frequency and criteria.)

SUMMARY OF INORGANIC METHOD CALIBRATIONS

		NPDES 1		**RCRA (SW846) 2**	
Analysis	**Calibration**	**Method**	**Requirement**	**Method**	**Requirement**
Alkalinity, Bicarbonate, Carbonate	Initial	310.1 2320B	2 point calibration of pH meter ± 0.05 pH units of true value	--	N/A
	Continuing	310.1 2320B	One buffer check ± 0.05 pH units of true value Everyone 10 samples	--	N/A
	Ending	310.1 2320B	N/A	--	N/A
Ammonia	Initial	350.1	6 levels including blank, "r" 3 ≥ 0.995	--	N/A
	Continuing	350.1	One level or LCS every 10 samples ± 10% of true value	--	N/A
	Ending	350.1	One level or LCS every 10 samples ± 10% of true value	--	N/A

		NPDES 1		RCRA (SW846) 2	
Analysis	Calibration	Method	Requirement	Method	Requirement
Biochemical Oxygen Demand (BOD)	Initial	405.1 SM5210B	a. Winkler titration: Iodometric with standard thiosulfate b. Membrane electrode: Read in air and in water with zero dissolved oxygen	--	N/A
	Continuing	405.1 SM5210B	N/A	--	N/A
	Ending	405.1 SM5210B	N/A	--	N/A

Analysis	Calibration	NPDES 1		RCRA (SW846) 2	
		Method	Requirement	Method	Requirement
Anions, Bromide, Chloride, Fluoride, Sulfate, Nitrite, Nitrate, O-Phos	Initial	300.0A	5 levels plus a blank, "r"3 ≥ 0.995	9056A	5 levels plus a blank, "r" 3 ≥ 0.995
	Continuing	300.0A	Level every 10 samples ± 10% of true value	9056A	N/A
	Ending	300.0A	N/A	9056A	N/A
Chemical Oxygen Demand (COD)	Initial	410.4 SM5220D	5 levels plus a blank"r" 3 ≥ 0.995	--	N/A
	Continuing	410.4 SM5220D	One level every 10 samples ± 10% of true value	--	N/A
	Ending	410.4 SM5220D	One level ± 10% of true value	--	N/A

Analysis	Calibration	NPDES 1		RCRA (SW846) 2	
		Method	Requirement	Method	Requirement
Chloride	Initial	325.2 SM4500 Cl-E	5 levels plus blank "r" 3 ≥ 0.995	9251	5 levels plus blank "r" 3 ≥ 0.995
	Continuing	325.2 SM4500 Cl-E	One level every 10 samples ± 10% of true value	9251	One level every 10 samples, ± 10% of true value
	Ending	325.2 SM4500 Cl-E	One level every 10 samples ± 10% of true value	9251	Method 9056 : N/A Method 9252: One level ± 10% of true value
Chromium Cr+6	Initial	3500 Cr-B	3 levels plus blank	7196A	5 levels plus blank "r" 3 ≥ 0.995
	Continuing	3500 Cr-B	One level every 10 samples ± 10% of true value	7196A	One level every 10 samples ± 15%

Analysis	Calibration	NPDES 1		RCRA (SW846) 2	
		Method	Requirement	Method	Requirement
	Ending	3500 Cr-B	One level ± 10% of true value	7196A	One level ± 15%
Chlorine, Residual	Initial	330.5 SM4500CL-G	N/A	--	N/A
	Continuing	330.5 SM4500CL-G	N/A	--	N/A
	Ending	330.5 SM4500CL-G	N/A	--	N/A

Analysis	Calibration	NPDES 1		RCRA (SW846) 2	
		Method	Requirement	Method	Requirement
Conductivity	Initial	120.1 SM2510B	Standard KCl solution	9050A	One level to determine cell constant
	Continuing	120.1 SM2510B	N/A	9050A	N/A
	Ending	120.1 SM2510B	N/A	9050A	N/A
Cyanide (Amenable)	Initial	335.1 SM4500CN-G	6 levels plus blank "r" 3 ≥ 0.995	9012A, B	6 levels plus blank "r" 3 ≥ 0.995
	Continuing	335.1 SM4500CN-G	One level every 10 samples ± 10% of true	9012A, B	One mid-level every 10 samples ± 15% of true value
	Ending	335.1 SM4500CN-G	One level ± 10 % of true value	9012A, B	± 15% of true value
Cyanide (Total)	Initial	335.2 335.4 SM4500CN-E 335.2-CLP-M (Ohio VAP)	6 levels plus blank "r" 3 ≥ 0.995	9012A, B	6 levels plus blank "r" 3 ≥ 0.995
	Continuing	335.2 335.4 SM4500CN-E 335.2-CLP-M (Ohio VAP)	One mid-level every 10 samples ± 10 % of true value	9012A, B	One mid-level every 10 samples ± 15% of true value
	Ending	335.2 335.4 SM4500CN-E 335.2-CLP-M (Ohio VAP)	One mid-level ± 10 % of true value	9012A, B	± 15% of true value

Analysis	Calibration	NPDES 1		RCRA (SW846) 2	
		Method	Requirement	Method	Requirement
Cyanide (Weak Acid Dissociable)	Initial	SM 4500 CN-I	6 levels plus blank "r" 3 ≥ 0.995		
	Continuing	SM 4500 CN-I	One mid-level every 10 samples ± 10 % of true value		
	Ending	SM 4500 CN-I	One mid-level ± 10 % of true value		
Flashpoint	Initial	--	N/A	1010, 1010A	p-Xylene reference standard must have flashpoint of 81oF ±2oF
	Continuing	--	N/A	1010, 1010A	N/A
	Ending	--	N/A	1010, 1010A	N/A

Analysis	Calibration	NPDES 1		RCRA (SW846) 2	
		Method	Requirement	Method	Requirement
Fluoride	Initial	340.2 SM 4500 F-C	5 levels “r” 3 ≥ 0.995		
	Continuing	340.2 SM 4500 F-C	One mid-level every 10 samples ± 10% of true value		
	Ending	340.2 SM 4500 F-C	One mid-level ± 10% of true value		
Hardness	Initial	130.2 SM 2340B SM2340C	Method 130.2: Standardize titrant Method 2340B: See ICP Metals 200.7	--	N/A
	Continuing	130.2 SM2340B SM2340C	Method 130.2: N/A Method 2340B: See ICP Metals 200.7	--	N/A
	Ending	130.2 SM2340B SM2340C	Method 130.2: N/A Method 2340B: See ICP Metals 200.7	--	N/A
Iron (Ferrous)	Initial	SM3500-Fe B	3 levels plus a blank, “r” 3 ≥ 0.995	-	N/A

Analysis	Calibration	NPDES 1		RCRA (SW846) 2	
		Method	Requirement	Method	Requirement
	Continuing	SM3500-Fe B	One mid-level every 10 samples ± 10% of true value	-	N/A
	Ending	SM3500-Fe B	One mid-level ± 10% of true value	-	N/A

Analysis	Calibration	NPDES 1		RCRA (SW846) 2	
		Method	Requirement	Method	Requirement
Phosphorus (Total and Ortho-phosphate)	Initial	365.1 SM4500P-E	5 levels plus a blank	--	N/A
	Continuing	365.1 SM4500P-E	One level for every 10 samples. ±10% of true value	--	N/A
	Ending	365.1 SM4500P-E	±10% of true value	--	N/A
pH	Initial	150.1 SM4500H-B	2 level calibration that bracket the expected pH of the sample ± 0.05 pH units of true value	9040B 9040C 9041A 9045C	2 point calibration ± 0.05 pH units of true value
	Continuing	150.1 SM4500H-B	One buffer check every 10 samples ± 0.05 pH units true value	9040B 9040C 9041A 9045C	N/A
	Other	150.1 SM4500H-B	Third point check	9040B 9040C 9041A 9045C	Third point check
	Ending	150.1 SM4500H-B	One buffer check ± 0.05 pH units of true value	9040B 9040C 9041A 9045C	N/A

Analysis	Calibration	NPDES 1		RCRA (SW846) 2	
		Method	Requirement	Method	Requirement
Phenolics	Initial	420.1	5 levels plus a blank "r" 3 ≥ 0.995	9065	5 levels plus a blank “r” 3 0.995
	Continuing	420.1	One mid-level every 10 samples ± 10% true value	9065	One mid-level ± 10% true value
	Ending	420.1	One mid-level ± 10% true value	9065	One mid-level ± 10% true value
Settleable Solids	Initial	160.5 SM2540F	N/A	--	N/A
	Continuing	160.5 SM2540F	N/A	--	N/A
	Ending	160.5 SM2540F	N/A	--	N/A
Sulfate	Initial	375.4	Method 375.4: 3 levels plus blank "r" 3 ≥ 0.995	9038	3 levels plus a blank for every hour of continuous sample analysis.

Analysis	Calibration	NPDES 1		RCRA (SW846) 2	
		Method	Requirement	Method	Requirement
Sulfate (Cont'd)	Continuing	375.4	One level every 3 or 4 samples ± 10% of true value	9038	Independent-prepared check standard every 15 samples
	Ending	375.4	± 10% of true value	9038	N/A
Sulfide	Initial	376.1 SM4500S 2-F	This is a titration method. Therefore, calibrations are not applicable.	9030B/ 9034	This is a colorimetric titration. Therefore, calibration is not applicable.
	Continuing	376.1 SM4500S 2-F	N/A	9030B/ 9034	This is a colorimetric titration. Therefore, calibration is not applicable.
	Ending	376.1 SM4500S 2-F	N/A	9030B/ 9034	This is a colorimetric titration. Therefore, calibration is not applicable.
Total Dissolved Solids	Initial	160.1 SM2540C	This is a gravimetric determination. Calibrate balance prior to analysis	--	N/A
	Continuing	160.1 SM2540C		--	N/A
	Ending	160.1 SM2540C		--	N/A

Analysis	Calibration	NPDES 1		RCRA (SW846) 2	
		Method	Requirement	Method	Requirement
Total Kjeldahl Nitrogen (TKN)	Initial	351.3 SM4500NH3-C	Method 351.3: Titrimetric: Standardize titrant Colorimetric: 7 levels plus blank	--	N/A
	Continuing	351.3 SM4500NH3-C	Method 351.3: N/A	--	N/A
	Ending	351.3 SM4500NH3-C	Method 351.3: N/A	--	N/A
Total Organic Carbon (TOC)	Initial	415.1 SM5310C	3 levels plus blank	9060 Walkley Black	3 levels plus blank "r" 3 ≥ 0.995
	Continuing	415.1 SM5310C	1 mid-level every 10 samples ± 10% of true value	9060 Walkley Black	1 mid-level every 10 samples ± 15% of true value
	Ending	415.1 SM5310C	± 10% of true value	9060 Walkley Black	± 15% of true value
Extractable Organic Halides (EOX)	Initial			9023	Daily instrument calibration standard and blank in duplicate ± 10% of true value (calibration standard) Verify with independently-prepared check standard –ICV ± 10%

Analysis	Calibration	NPDES 1		RCRA (SW846) 2	
		Method	Requirement	Method	Requirement
Extractable Organic Halides (EOX) (cont'd)	Continuing			9023	CCV ± 10% of true value
	Ending			9023	CCV ± 10% of true value
Total Solids	Initial	160.3	This is a gravimetric determination. Calibrate balance before use.	--	N/A
	Continuing	160.3		--	N/A
	Ending	160.3		--	N/A
Total Suspended Solids (Nonfilterable)	Initial	160.2 SM2540D	This is a gravimetric determination. Calibrate balance before use.	--	N/A
	Continuing	160.2 SM2540D		--	N/A
	Ending	160.2 SM2540D		--	N/A
Turbidity	Initial	180.1	Minimum of 1 level in each instrument range. Follow manufacturer's instructions	--	N/A
	Continuing	180.1	± 10% of true value	--	N/A
	Ending	180.1	± 10% of true value	--	N/A

Analysis	Calibration	NPDES 1		RCRA (SW846) 2	
		Method	Requirement	Method	Requirement
ICP & ICP/MS Metals (excludes Hg)	Initial	200.7	One level and blank. ICV RSD <3% from replicate - daily	6010B 6010C	One level and blank. ICV RSD <5% from replicate - daily
	Initial	200.8	One level and blank	6020 6020A	One level and blank
	Continuing	200.7	Every 10 samples ±10% of true value CCV RSD < 5% from replicate	6010B 6010C	Mid-level calibration standard Every 10 samples ± 10% of true value CCV RSD < 5% from replicate
	Continuing	200.8	N/A	6020 6020A	N/A
	Ending	200.7	±10% of true value CCV RSD < 5% from replicate	6010B 6010C	Mid-level calibration standard ± 10% of true value CCV RSD < 5% from replicate
	Ending	200.8	N/A	6020 6020A	N/A
	Other	200.7	ICSA, ICSAB: Analyze at beginning of run. For ICSA, AB criteria see SOP Semi-Annually: ICP interelement correction factors Instrument detection limits	6010B 6010C	ICSA, ICSAB: Analyze at beginning of run. For ICSA, AB criteria see SOP Semi-Annually: ICP interelement correction factors Instrument detection limits
	Other	200.8	N/A	6020 6020A	N/A

Analysis	Calibration	NPDES 1		RCRA (SW846) 2	
		Method	Requirement	Method	Requirement
Mercury by CVAA & CVAFS	Initial	245.1 1631E	5 levels plus blank ICV ±10% of true value "r" 3 ≥ 0.995	7470A 7471A 7471B	5 levels plus blank ICV ± 10% of true value "r" 3 ≥ 0.995
	Continuing	245.1* 1631E	Daily or every 10 samples, whichever is more frequent ±20% of true value	7470A 7471A 7471B	Every 10 samples ±20% of true value
	Ending	245.1 1631E	±20% of true value	7470A 7471A 7471B	±20% of original prepared standard
	Other	245.1 1631E	Annually: MDL	7470A 7471A 7471B	Annually: MDL

* 245.1 continuing – Initial CCV ±5% of true value

Footnotes

1 National Pollutant Discharge Elimination System.

2 Resource Conservation and Recovery Act, Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, (SW-846), Third Edition, September 1986. Contains Final Update I (July 1992), Final Update IIA (August 1993), Final Update II (September 1994), Final Update IIB (January 1995), and Final Update III (December, 1996).

3 "r" = correlation coefficient.

SUMMARY OF ORGANIC METHOD CALIBRATIONS

		NPDES 1		RCRA (SW846) 2	
Analysis	Calibration	Method	Requirement	Method	Requirement
Herbicides by GC	Initial			8151A	Minimum of 5 levels If % RSD < 20%, use avg RF. Otherwise, calibration curve employed.
	Continuing			8151A	Mid-level calibration standard analyzed every 10 samples. % D < 15% of predicted response for any analyte quantitated and reported.
	Ending			8151A	Mid-level calibration standard. % D < 15% of predicted response for any analyte quantitated and reported.

Analysis	Calibration	NPDES 1		RCRA (SW846) 2	
		Method	Requirement	Method	Requirement
Pesticides/ PCBs by GC	Initial	608	Minimum of 3 levels If % RSD < 10%, use avg RF. Otherwise, calibration curve employed	8081A 8081B 8082 8082A	Minimum of 5 levels. If % RSD < 20%, use avg RF. Otherwise, calibration curve employed. (See SOP NC-GC-038)
	Continuing	608	One or more calibration standards analyzed daily. % D ± 15% of predicted response	8081A 8081B 8082 8082A	Mid-level calibration standard analyzed every 10 samples. % D < 15% of predicted response for any analyte quantitated and reported.
	Ending	608	N/A	8081A 8081B 8082 8082A	Mid-level calibration standard. % D < 15% of predicted response for any analyte quantitated and reported.
	Other	608	N/A	8081A 8081B 8082 8082A	N/A
Petroleum Hydrocarbons /Oil and Grease	Initial	1664A	Calibrate analytical balance at 2 mg and 1000 mg Calibration must be ± 10% at 2 mg and ± 0.5% at 1000 mg or recalibrate balance		
	Continuing	1664A	N/A		
	Ending	1664A	N/A		

Analysis	Calibration	NPDES 1		RCRA (SW846) 2	
		Method	Requirement	Method	Requirement
Semivolatiles	Initial	625	Minimum of 3 levels, lowest near but above MDL. If % RSD ≤ 35%, use avg RF. Otherwise calibration curve employed.	8270C 8270D	Minimum of 5 levels, % RSD for RF for CCCs(4) < 30% SPCCs(5): RF > 0.050
	Continuing	625	One level every 24 ours. Acceptance criteria are found in the method and SOP.	8270C 8270D	Mid-level standard every 12 hours (after tuning) %D for CCCs(4) < 20 % between RF from standard and avg RF from initial SPCCs(5): RF > 0.050.
	Ending	625	N/A	8270C 8270D	N/A
	Other	625	DFTPP(7) tuning every 24 hours before standard or sample runs.	8270C 8270D	DFTPP(7) tuning at the beginning of every 12 hour shift.

Analysis	Calibration	NPDES 1		RCRA (SW846) 2	
		Method	Requirement	Method	Requirement
Volatiles	Initial	624	Minimum of 3 levels, lowest near but above MDL. If % RSD ≤ 35%, use avg RF. Otherwise, calibration curve employed.	8260B 8260C	Minimum of 5 levels, %RSD for RF for CCCs4 < 30.0% SPCCs5:RF ≥ 0.300 for Chlorobenzene and 1,1,2,2-tetrachloroethane, Chloromethane and 1,1-dichloroethane, and RF > 0.100 for Bromoform
	Continuing	624	1 level every 24 hours Acceptance criteria are found in the method and SOP	8260B 8260C	Mid-level standard every 12 hours (after tuning) %Drift for CCCs(4) < 20.0% between RF from standard and avg RF from initial SPCCs(5): RF ≥ 0.300 for Chlorobenzene and 1,1,2,2-tetrachloroethane, Chloromethane and 1,1-dichloroethane, and RF > 0.100 for Bromoform
	Ending	624	N/A	8260B 8260C	N/A
	Other	624	BFB(6)tuning at the beginning of every 24 hour shift.	8260B 8260C	BFB(6)tuning at the beginning of every 12 hour shift.

Footnotes:

1 National Pollutant Discharge Elimination System.

2 Resource Conservation and Recovery Act, Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, (SW-846), Third Edition, September 1986. Contains Final Update I (July 1992), Final Update IIA (August 1993), Final Update II (September 1994), Final Update IIB (January 1995), and Final Update III (December 1996).

3 TCDD - 2,3,7,8-Tetrachlorodibenzo-p-dioxin.

4 CCC - Continuing Calibration Compounds.

5 SPCC - System Performance Check Compound.

6 BFB – Bromofluorobenzene.

7 DFTPP – Decafluorotriphenylphosphine.

8 Footnote deleted.

9 Method not listed in 40 CFR Part 136.

21. MEASUREMENT TRACEABILITY

21.1. Traceability of measurements must be assured using a system of documentation, calibration, and analysis of reference standards. Laboratory equipment that are peripheral to analysis and whose calibration is not necessarily documented in a test method analysis or by analysis of a reference standard must be subject to ongoing certifications of accuracy. At a minimum, these must include procedures for checking specifications of ancillary equipment: balances, thermometers, temperature, Deionized (DI) and Reverse Osmosis (RO) water systems, automatic pipettes and other volumetric measuring devices (refer to Section 20.3). With the exception of Class A glassware and glass microliter syringes , quarterly accuracy checks are performed for all mechanical volumetric devices. Microsyringes are verified at least semi-annually or disposed of after six months of use. Wherever possible, subsidiary or peripheral equipment is checked against standard equipment or standards that are traceable to national or international standards. Class A glassware and glass microliter syringes should be routinely inspected for chips, acid etching, or deformity (e.g., bent needle). If the Class A glassware or syringe are suspect, the accuracy of the glassware must be assessed prior to use. Actions to correct or segregate ancillary equipment that does not meet required specifications are identified in the calibration and maintenance section of SOPs and maintenance logbooks for the specific equipment.

21.2. NIST-Traceable Weights and Thermometers

21.2.1. Reference standards of measurement must be used for calibration only and for no other purpose, unless it can be shown that their performance as reference standards would not be invalidated.

21.2.2. For NIST-traceable weights and thermometers, the laboratory requires that all calibrations be conducted by a calibration laboratory accredited by A2LA, NVLAP (National Voluntary Laboratory Accreditation Program), APLAC (Asia-Pacific Laboratory Accreditation Cooperation), or another accreditation organization that is a signatory to a MRA (Mutual Recognition Arrangement) of one or more of the following cooperations – ILAC (International Laboratory Accreditation Cooperation) or APLAC (Asia-Pacific Laboratory Accreditation Cooperation). A calibration certificate and scope of accreditation is kept on file at the laboratory. Refer to Section 21 for calibration of weights and thermometers.

21.2.3. An external certified service engineer services laboratory balances on an annual basis. This service is documented on each balance with a signed and dated certification sticker. Balance calibrations are checked each day of use. All mercury thermometers are calibrated annually against a traceable reference thermometer. Temperature readings of ovens, refrigerators, and incubators are checked on each day of use.

21.3. Reference Standards / Materials

21.3.1. Reference standards/materials, where commercially available, are traceable to certified reference materials. Commercially prepared standard materials are purchased from vendors accredited by ISO Guide 34 and ISO/IEC Guide 17025, with an accompanying Certificate of Analysis that documents the following information:

21.3.1.1. Manufacturer

21.3.1.2. Analytes or parameters calibrated

21.3.1.3. Identification or lot number

21.3.1.4. Calibration method

21.3.1.5. Concentration with associated uncertainties

21.3.1.6. Purity

21.3.2. If a standard cannot be purchased from a vendor that supplies a Certificate of Analysis, the purity of the standard is documented by analysis. (Refer to Section 9 for additional information on purchasing). The receipt of all reference standards must be documented. Reference standards are labeled with a unique Standard Identification Number and expiration date. All documentation received with the reference standard is retained as a QC record and references the Standard Identification Number.

21.3.3. All reference, primary and working standards/materials, whether commercially purchased or laboratory prepared, must be checked regularly to ensure that the variability of the standard or material from the 'true' value does not exceed method requirements. The accuracy of calibration standards is checked by comparison with a standard from a second source. In cases where a second standard manufacturer is not available, a vendor-certified different lot is acceptable for use as a second source. For unique situations, where no other source or lot is available, a standard made by a different analyst would be considered a second source. The appropriate Quality Control (QC) criteria for specific standards are defined in laboratory SOPs. In most cases, the analysis of an Initial Calibration Verification (ICV) or LCS (where there is no sample preparation) is used as the second source confirmation. These checks are generally performed as an integral part of the analysis method (e.g., calibration checks, laboratory control samples).

21.3.4. All standards and materials must be stored and handled according to method or manufacturer's requirements in order to prevent contamination or deterioration. Refer to The Corporate Environmental Health & Safety Manual (CW-E-M-001) or laboratory SOPs. For safety requirements,

please refer to method SOPs and the laboratory Environmental Health and Safety Manual.

21.3.5. Standards and reference materials must not be used after their expiration dates unless their reliability is verified by the laboratory and their use is approved by the Quality Assurance Manager. The laboratory must have documented contingency procedures for re-verifying expired standards. Some regulatory programs, such as Ohio VAP, prohibit the use of re-verified standards.

21.4. Documentation And Labeling Of Standards, Reagents, And Reference Materials

21.4.1. Reagents must be at a minimum the purity required in the test method. The date of reagent receipt and the expiration date are documented. The lots for most of the common solvents and acids are tested for acceptability prior to companywide purchase. Refer to TestAmerica's Corporate SOP CA-Q-S-001, Solvent and Acid Lot Testing and Approval.

21.4.2. All manufacturer or vendor-supplied Certificate of Analysis or Purity must be retained, stored appropriately, and readily available for use and inspection. These records are maintained in each group. Records must be kept of the date of receipt and date of expiration of standards, reagents and reference materials. In addition, records of preparation of laboratory standards, reagents, and reference materials must be retained, stored appropriately, and be readily available for use and inspection.

21.4.3. Commercial materials purchased for preparation of calibration solutions, spike solutions, etc., are usually accompanied with an assay certificate or the purity is noted on the label. If the assay purity is 96% or better, the weight provided by the vendor may be used without correction. If the assay purity is less than 96%, a correction must be made to concentrations applied to solutions prepared from the stock commercial material. Blended gas standard cylinders use a nominal concentration if the certified value is within +/-15%, otherwise the certified values are used for the canister gas concentrations.

21.4.4. All standards, reagents, and reference materials must be labeled in an unambiguous manner. Standards are logged into the laboratory's LIMS system, and are assigned a unique identification number. The following information is typically recorded in the electronic database within the LIMS:

21.4.4.1. Standard ID

21.4.4.2. Description of Standard

21.4.4.3. Department

21.4.4.4. Preparer's name

21.4.4.5. Final volume and number of vials prepared

21.4.4.6. Solvent type and lot number

21.4.4.7. Preparation date

21.4.4.8. Expiration date

21.4.4.9. Standard source type (stock or daughter)

21.4.4.10. Standard type (spike, surrogate, other)

21.4.4.11. Parent standard ID (if applicable)

21.4.4.12. Parent standard analyte concentration (if applicable)

21.4.4.13. Parent standard amount used (if applicable)

21.4.4.14. Component analytes

21.4.4.15. Final concentration of each analyte

21.4.4.16. Comment box (text field)

21.4.5. Records are maintained electronically in each group for standard and reference material preparation. These records show the traceability to purchased stocks or neat compounds. These records also include method of preparation, date of preparation, expiration date, and preparer's name or initials. Preparation procedures are provided in the Method SOPs.

21.4.6. All standards, reagents, and reference materials must be clearly labeled with a minimum of the following information:

21.4.6.1. Expiration date (include prep date for reagents)

21.4.6.2. Standard ID (from LIMS)

21.4.6.3. Special health/safety warnings, if applicable

21.4.7. Records must also be maintained of the date of receipt for commercially purchased items or date or preparation for laboratory prepared items. Special health/safety warnings must also be available to the analyst. This information is maintained in the analytical SOP.

21.4.8. In addition, the following information may be helpful:

21.4.8.1. Date of receipt for commercially purchased items or date of preparation for laboratory prepared items

21.4.8.2. Date opened (for multi-use containers, if applicable)

21.4.8.3. Description of standard (if different from manufacturer's label or if standard was prepared in the laboratory)

21.4.8.4. Recommended storage conditions

21.4.8.5. Concentration (if applicable)

21.4.8.6. Initials of analyst preparing standard or opening container

21.4.9. All containers of prepared reagents must include an expiration date, and an ID number to trace back to preparation.

21.4.10. Procedures for preparation of reagents can be found in the Method SOPs.

21.4.11. Standard ID numbers must be traceable through associated logbooks, worksheets, and preparation and batch records.

21.4.12. All reagents and standards must be stored in accordance to the following priority:

21.4.12.1. With the manufacturer's recommendations

21.4.12.2. With requirements in the specific analytical methods as specified in the laboratory SOP

22. SAMPLING

22.1. The laboratory provides sampling services. Sampling procedures are described in SOP NC-SC-006, Sample Procurement Protocol.

22.2. Sampling Containers

22.2.1. The laboratory offers clean sampling containers for use by clients. These containers are obtained from reputable container manufacturers and meet EPA specifications as required. Certificates of cleanliness provided by the supplier are maintained at the laboratory. Alternatively, the certificates are available from the vendor electronically and available to the laboratory online.

22.3. Preservatives

22.3.1. Upon request, preservatives are provided to the client in pre-cleaned sampling containers. In some cases containers may be purchased pre-preserved from the container supplier. Whether prepared by the laboratory or bought pre-preserved, the grades of the preservatives are at a minimum:

22.3.1.1. Hydrochloric Acid – Reagent ACS (Certified VOA Free) or equivalent

22.3.1.2. Methanol – Purge and Trap grade

22.3.1.3. Nitric Acid – Instra-Analyzed or equivalent

22.3.1.4. Sodium Bisulfate – ACS Grade or equivalent

22.3.1.5. Sodium Hydroxide – Instra-Analyzed or equivalent

22.3.1.6. Sulfuric Acid – Instra-Analyzed or equivalent

22.3.1.7. Sodium Thiosulfate – ACS Grade or equivalent

22.4. Definition Of Holding Time

22.4.1. The date and time of sampling documented on the Chain-of-Custody (COC) form establishes the day and time zero. As a general rule, when the maximum allowable holding time is expressed in “days” (e.g., 14 days, 28 days), the holding time is based on calendar day measured. Holding times expressed in “hours” (e.g., 6 hours, 24 hours, etc.) are measured from date and time zero. The first day of holding time ends 24 hours after sampling. Holding times for analysis include any necessary re-analysis. However, there are some programs that determine holding time compliance based on the date and specific time of analysis compared to the time of sampling regardless of holding time length.

22.5. Sampling Containers, Preservation Requirements, Holding Times

22.5.1. The preservation and holding time criteria specified in the following tables are derived from the source documents for the methods. If method-required holding times (refer to Tables 23-1 to 23-7 and in SOPs) or preservation requirements are not met, the reports must be qualified using a flag, footnote, or case narrative. As soon as possible, or “ASAP”, is an EPA designation for tests for which rapid analysis is advised; but for which neither EPA nor the laboratory have a basis for a holding time.

22.6. Sample Aliquots / Subsampling

22.6.1. Taking a representative sub-sample from a container is necessary to ensure that the analytical results are representative of the sample collected in the field. The size of the sample container, the quantity of sample fitted within the container, and the homogeneity of the sample needs consideration when sub-sampling for sample preparation. It is the laboratory’s responsibility to take a representative sub-sample or aliquot of the sample provided for analysis. In that regard the following guidelines apply to analysts:

22.6.2. Analysts should handle each sample as if it is potentially dangerous. At a minimum, safety glasses, gloves, and lab coats must be worn when preparing aliquots for analysis.

22.6.3. Guidelines on taking sample aliquots and sub-sampling are located in each analytical SOP.

22.6.4. Tables 23-1 to 23-7 detail holding times, preservation and container requirements, and sample volumes for NPDES methods. The sample volumes are intended to be a minimal amount to perform the method. The containers used may be of larger size.

Please note: The holding times are program specific and different programs may have different holding times for equivalent methods, e.g., there are differences in holding times for many organic analytes between RCRA and NPDES.

Table 22-1. Inorganic Sample Containers, Preservatives, and Holding Times

Analytical Parameters	Matrix	Minimum Sample Size 1	NPDES 2, 3, 7		RCRA (SW846) 3, 4	
			Method	Requirements	Method	Requirements
Alkalinity, Bicarbonate, Carbonate	Water	100 mL	310.1 SM2320B	250 mL plastic or glass. Cool to 4°C, 14 days	---	N/A
	Solid	N/A	---	N/A	---	N/A
	Waste	N/A	---	N/A	---	N/A
Ammonia	Water	100 mL	350.2 SM4500NH3-C SM4500NH3-B	500 mL plastic or glass. Cool to 4°CH2SO4 to pH < 2, 28 days	---	N/A
	Solid	N/A	---	N/A	---	N/A
	Waste	N/A	---	N/A	---	N/A
Biochemical Oxygen Demand (BOD), Carbonaceous	Water	1000 mL	405.1 SM5210B	1000 mL plastic or glass. Cool to 4°C, 48 hours	---	N/A
	Solid	N/A	---	N/A	---	N/A
	Waste	N/A	---	N/A	---	N/A
Anions, Bromide, Chloride, Fluoride, Sulfate,	Water	50 mL	300.0A7	250 mL plastic or glass. No preservative required, 28 days	9056A	Cool to 4°C. Analyze ASAP after collection
	Solid	N/A	---	N/A	---	N/A
	Waste	N/A	---	N/A	---	N/A
Anions, Nitrate, Nitrite, ortho-Phosphate	Water	50 mL	300.0A 7	250 mL plastic or glass. Cool to 4°C, 48 hours.	9056A	Cool to 4°C. Analyze within 48 hours of collection
	Solid	N/A	---	N/A	---	N/A
	Waste	N/A	---	N/A	---	N/A
Chemical Oxygen Demand (COD)	Water	100 mL	410.4 5220D	250 mL glass or plastic. Cool to 4°C, H2SO4 to pH < 2, 28 days	---	N/A
	Solid	N/A	---	N/A	---	N/A
	Waste	N/A	---	N/A	---	N/A

Analytical Parameters	Matrix	Minimum Sample Size 1	NPDES 2, 3, 7		RCRA (SW846) 3, 4	
			Method	Requirements	Method	Requirements
Chloride	Water	50 mL	325.2 SM 4500-Cl-E	250 mL plastic or glass. No preservative required, 28 days	9251	Method 9251: 250ml plastic or glass, no preservative required, 28 days
	Solid	N/A	---	N/A	---	N/A
	Waste	N/A	---	N/A	---	N/A
Chlorine, Residual	Water	100 mL	330.5 SM 4500 Cl-G	250 mL glass or plastic. Cool to 4°C, analyze immediately	---	N/A
	Solid	N/A	---	N/A	---	N/A
	Waste	N/A	---	N/A	---	N/A
Chromium (Cr+6)	Water	100 mL	3500 Cr-B	Method 3500 Cr-D: 200 mL quartz, TFE, or polypropylene HNO3 to pH <2. Cool to 4°C. Analyze ASAP after collection	7196A	200 mL plastic or glass. Cool to 4°C, 24 hours
	Solid	20 g	---	N/A	7196A 3060A	250 mL plastic or glass, 30 days to digestion, 168 hours after digestion
	Waste	N/A	---	N/A	---	N/A
Conductivity	Water	100 mL	120.1 SM2510B	200 mL glass or plastic. Cool to 4°C, 28 days	9050A	200 mL glass or plastic. Cool to 4°C, 28 days
	Solid	N/A	---	N/A	---	N/A
	Waste	N/A	---	N/A	---	N/A

Analytical Parameters	Matrix	Minimum Sample Size 1	NPDES 2, 3, 7		RCRA (SW846) 3, 4	
			Method	Requirements	Method	Requirements
Cyanide (Amenable)	Water	250 mL	335.1 SM4500CN-G	1 liter plastic or glass, NaOH to pH >12 Cool to 4°C, 14 days unless sulfide is present. Then maximum holding time is 24 hours.	9012A, B	1 liter plastic or glass, NaOH to pH >12 Cool to 4°C, 14 days
	Solid	50g	---	N/A	9012A, B	Not Specified
	Waste	50g	---	N/A	9012A, B	Not Specified
Cyanide (Total)	Water	1L	335.2 335.3 335.4 (7) SM4500CN-E 335.2-CLP-M	1 liter plastic or glass, NaOH to pH >12 Cool to 4°C, 14 days unless sulfide is present. Then maximum holding time is 24 hours.	9012A, B	1 liter plastic or glass, NaOH to pH >12 Cool to 4°C, 14 days.
	Solid	50g	--	N/A	9012A, B	8 or 16 oz glass Teflon-lined lids, Cool to 4°C, 14 days
	Waste	50g	--	N/A	9012A, B	8 or 16 oz glass Teflon-lined lids, Cool to 4°C
Flashpoint (Ignitability)	Liquid	100 mL	---	N/A	1010, 1010A	No requirements, 250 mL amber glass. Cool to 4°C recommended
	Solid	100 g	--	N/A	---	N/A
	Waste	100 mL	--	N/A	---	N/A
Fluoride	Water	300 mL	340.2 SM 4500 F-C	500 mL plastic. No preservation required, 28 days.		
	Solid	N/A	---	N/A	---	N/A
	Waste	N/A	---	N/A	---	N/A

Analytical Parameters	Matrix	Minimum Sample Size 1	NPDES 2, 3, 7		RCRA (SW846) 3, 4	
			Method	Requirements	Method	Requirements
Hardness (Total)	Water	50 mL	130.2 SM2340C	250 mL glass or plastic, HNO3 to pH < 2, 6 months	---	N/A
	Solid	N/A	---	N/A	---	N/A
	Waste	N/A	---	N/A	---	N/A
Iron (Ferrous)	Water	100 mL	3500-Fe B	1 liter glass or polyethylene containe. This test should be performed in the field.	-	N/A
	Solid	N/A	-	N/A	-	N/A
	Waste	N/A	-	N/A	-	N/A
Ortho-phosphate	Water	50 mL	365.1 SM4500P-E	100 mL plastic or glass. Filter on site. Cool to 4°C, 48 hours		
	Solid	N/A	---	N/A	---	N/A
	Waste	N/A	---	N/A	---	N/A

Analytical Parameters	Matrix	Minimum Sample Size 1	NPDES 2, 3, 7		RCRA (SW846) 3, 4	
			Method	Requirements	Method	Requirements
pH	Water	50 mL	150.1 SM4500H-B	100 mL plastic or glass. Analyze immediately. This test should be performed in the field.	9040B, C	100 mL plastic or glass. Analyze immediately. This test should be performed in the field.(8)
	Solid	N/A	---	N/A	9045C, D	4 oz glass or plastic. Cool to 4°C. Analyze as soon as possible.8
	Waste	N/A	---	N/A	9045C, D	4 oz glass or plastic, Cool to 4°C. Analyze as soon as possible.8
Phenolics	Water	100 mL	420.1	500 mL glass, Cool to 4°C, H2SO4 to pH < 2, 28 days	9065	1 liter glass recommended, Cool to 4°C, H2SO4 to pH < 4, 28 days
	Solid	N/A	---	N/A	---	N/A

Analytical Parameters	Matrix	Minimum Sample Size 1	NPDES 2, 3, 7		RCRA (SW846) 3, 4	
			Method	Requirements	Method	Requirements
	Waste	N/A	---	N/A	9065	Not Specified

Analytical Parameters	Matrix	Minimum Sample Size 1	NPDES 2, 3, 7		RCRA (SW846) 3, 4	
			Method	Requirements	Method	Requirements
Phosphorus (Total)	Water	100 mL	365.1 SM4500P-E	100 mL plastic or glass, H2SO4 to pH < 2, 28 days	---	N/A
	Solid	N/A	---	N/A	---	N/A
	Waste	N/A	---	N/A	---	N/A
Settleable Solids	Water	1000 mL	160.5 SM2540F	1000 mL plastic or glass. Cool to 4°C, 48 hours	---	N/A
	Solid	N/A	---	N/A	---	N/A
	Waste	N/A	---	N/A	---	N/A
Sulfate (SO4)	Water	50 mL	375.4	100 mL plastic or glass. Cool to 4°C, 28 days	9038	200 mL plastic or glass, Cool to 4°C, 28 days
	Solid	N/A	---	N/A	---	N/A
	Waste	100 mL	---	N/A	9038	200 mL plastic or glass. Cool to 4°C, 28 days

Analytical Parameters	Matrix	Minimum Sample Size 1	NPDES 2, 3, 7		RCRA (SW846) 3, 4	
			Method	Requirements	Method	Requirements
Sulfide	Water	250 mL	376.1 SM 4500 S2-F	500 mL plastic or glass. Cool to 4°C, Add 2 mL zinc acetate plus NaOH to pH > 9, 7 days	9030A 9030B/ 9034	500 mL plastic, No headspace. Cool to 4°C. Add 4 drops of 2N zinc acetate per 100 mL of sample, adjust the pH to > 9 with 6 N NaOH solution, 7 days
	Solid	50 g	---	N/A	9030A 9030B/ 9034	Cool to 4°C. Fill surface of solid with 2N Zinc acetate until moistened. Store headspace-free
	Waste	50 g	---	N/A	9030A 9030B/ 9034	Cool to 4°C. Fill surface of solid with 2N Zinc acetate until moistened. Store headspace-free
Total Dissolved Solids (Filterable)	Water	100 mL	160.1 SM2540C	250 mL plastic or glass. Cool to 4°C, 7 days	---	N/A
	Solid	N/A	---	N/A	---	N/A
	Waste	N/A	---	N/A	---	N/A

Analytical Parameters	Matrix	Minimum Sample Size 1	NPDES 2, 3, 7		RCRA (SW846) 3, 4	
			Method	Requirements	Method	Requirements
Total Kjeldahl Nitrogen (TKN)	Water	100 mL	351.3 SM 4500-NH3-C	500 mL plastic or glass. Cool to 4°C, H2SO4 to pH < 2, 28 days	---	N/A
	Solid	N/A	---	N/A	---	N/A
	Waste	N/A	---	N/A	---	N/A
Total Organic Carbon (TOC)	Water	100 mL	415.1 SM5310C	100 mL plastic or glass. Cool to 4°C, H2SO4 to pH < 2, 28 days	9060, 9060A	100 mL glass or 40 mL VOA vials,Cool to 4°C, H2SO4 or HCl to pH < 2, 28 days
	Solid	N/A	---	N/A	Walkley-Black	Not Specified Cool to 4°C, 28 days
	Waste	N/A	---	N/A	Walkley-Black	Not Specified Cool to 4°C, 28 days
Extractable Organic Halides (EOX)	Solid	100 mL			9023 (EOX)	500 mL amber glass, Teflon®-lined lid. Cool to 4°Cno headspace, 28 days
Total Solids	Water	100 mL	160.3	250 mL plastic or glass. Cool to 4°C, 7 days	---	N/A
	Solid	N/A	---	N/A	---	N/A
	Waste	N/A	---	N/A	---	N/A
Total Suspended Solids (Non-filterable)	Water	100 mL	160.2	250 mL plastic or glass. Cool, 4°C, 7 days	---	N/A
	Solid	N/A	---	N/A	---	N/A
	Waste	N/A	---	N/A	---	N/A

Analytical Parameters	Matrix	Minimum Sample Size 1	NPDES 2, 3, 7		RCRA (SW846) 3, 4	
			Method	Requirements	Method	Requirements
Turbidity	Water	50 mL	180.1	250 mL plastic or glass. Cool, 4°C, 48 hours	---	N/A
	Solid	N/A	---	N/A	---	N/A
	Waste	N/A	---	N/A	---	N/A
Metals (excludes Hg)	Water	100 mL	200 series	1 liter glass or polyethylene container, HNO3 to pH < 2, 6 months	6010B 6010C 6020 6020A	1 liter glass or polyethylene container, HNO3 to pH < 2, 6 months
	Solid	200 g	200 series	2, 8, or 16 oz glass or polyethylene container storage at 4 °C	6010B 6010C 6020 6020A	8 or 16 oz glass or polyethylene container, storage at 4°C, 6 months
	Waste	200 g	200 series	N/A	6010B 6010C 6020 6020A	8 or 16 oz glass or polyethylene container, storage at 4°C, 6 months
Mercury (CVAA) (CVAFS)	Water	100 mL	245.1 1631E	250 mL glass or polyethylene container, HNO3 to pH < 2, 28 days	7470A	1 liter glass or polyethylene container, HNO3 to pH < 2, 28 days
	Solid	200 g	--	2, 8, or 16 oz glass or polyethylene container. Cool to 4°C, 28 days. Not applicable for Method 1631E.	7471A 7471B	8 or 16 oz glass or polyethylene container. Cool to 4°C, 28 days (CORP-MT-0007)
	Waste	200 g	--	N/A	7471A 7471B	8 or 16 oz glass or polyethylene container. Cool, 4°C, 28 days (CORP-MT-0007)

Footnotes

1 *Minimum sample size indicates sample amount needed for a single analysis. Matrix spikes or duplicates will require an additional sample amount of at least this amount for each additional QC sample aliquot required.*

2 *National Pollutant Discharge Elimination System - MCAWW, March 1983.*

3 *Holding times are calculated from date of collection. Holding Times are determined based on date of collection to preparation/analysis.*

4 *Resource Conservation and Recovery Act, Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, (SW-846), Third Edition, September 1986. Contains Final Update I (July 1992), Final Update IIA, (August 1993), Final Update II (September 1994), Final Update IIB (January 1995), and Final Update III (December 1996).*

5 *Solid matrix type includes soil, sediment, sludge and other solid materials not classified as waste.*

6 Samples to be analyzed for cyanide should be field-tested for residual chlorine. If residual chlorine is detected, ascorbic acid should be added.
7 Method not listed in 40 CFR Part 136.
8 If not done in the field (ASAP) per the method and requested by client, analyze in lab within 48 hours.

Table 22-2. Organic Sample Containers, Preservatives, and Holding Times

Analytical Parameters	Matrix	Minimum Sample Size 1	NPDES 2, 3		RCRA (SW846) 3, 4	
			Method	Requirements	Method 6	Requirements
Herbicides	Water	1L			8151A	1 liter amber glass with Teflon®-lined lid. If residual chlorine present, add 3 mL sodium thiosulfate per gallon. Cool to 4°C. Extraction, 7 days. Analysis, 40 days of the start of extraction.
	Solid	50 g			8151A	4 or 8 oz glass widemouth with Teflon®-lined lid. Cool to 4 °C. Extraction, 14 days. Analysis, 40 days of the start of the extraction.
	Waste	50 g			8151A	4 or 8 oz glass widemouth with Teflon®-lined lid. Cool to 4 °C. Extraction, 14 days. Analysis, 40 days of the start of the extraction.

Analytical Parameters	Matrix	Minimum Sample Size 1	NPDES 2, 3		RCRA (SW846) 3, 4	
			Method	Requirements	Method 6	Requirements
Pesticides/ PCBs	Water	1L	608	1 liter amber glass with Teflon®-lined lid, Adjust pH to 5-9 if extraction not to be done within 72 hours of sampling. Add sodium thiosulfate if residual chlorine present and aldrin is being determined. Cool, 4°C. Extraction, 1 year. Analysis, 40 days after extraction.	8081A 8081B 8082 8082A	1 liter amber glass with Teflon®-lined lid, If residual chlorine present, add 3 mL 10% sodium thiosulfate per gallon. Cool, 4°C. Extraction, 7 days (1 year for 8082A). Analysis, 40 days of the start of the extraction.
	Solid	50 g	---	N/A	8081A 8081B 8082 8082A	4 or 8 oz glass wide mouth with Teflon®-lined lid. Cool, 4°C. Extraction, 14 days (1 year for 8082A). Analysis, 40 days of the start of the extraction.
	Waste	50 g	---	N/A	8081A 8081B 8082 8082A	4 or 8 oz glass wide mouth with Teflon®-lined lid. Cool, 4°C. Extraction, 14 days (1 year for 8082A). Analysis, 40 days of the start of the extraction.

Analytical Parameters	Matrix	Minimum Sample Size 1	NPDES 2, 3		RCRA (SW846) 3, 4	
			Method	Requirements	Method 6	Requirements
Oil and Grease	Water	1 L	1664A(7)	1 liter glass, Cool, 4°C HCl or H2SO4 to pH <2 28 days		
	Solid	30 g	1664A(7)	8 or 16 oz. Wide mouth glass jar, Cool, 4°C, 28 days		
	Waste	---	---	N/A		
Semivolatiles	Water	1L	625	1 liter amber glass with Teflon®-lined lid. Cool, 4°C. Extraction, 7 days. Analysis, 40 days.	8270C 8270D	1 liter amber glass with Teflon®-lined lid, If residual chlorine present, add 3 mL sodium thiosulfate per gallon. Cool, 4°C. Extraction, 7 days. Analysis, within 40 days of extraction.
	Solid	50 g	---	N/A	8270C 8270D	8 or 16 oz glass wide mouth with Teflon-lined lid. Cool, 4°C. Extraction, 14 days. Analysis, within 40 days of extraction.
	Waste	50 g	---	N/A	8270C 8270D	8 or 16 oz glass wide mouth with Teflon®-lined lid. Cool, 4°C. Extraction, 14 days. Analysis, within 40 days of extraction.

Analytical Parameters	Matrix	Minimum Sample Size 1	NPDES 2, 3		RCRA (SW846) 3, 4	
			Method	Requirements	Method 6	Requirements
Volatile Organics	Water	40 mL	624	40 mL glass, VOA vial (in triplicate) with Teflon®-lined septa without headspace. Cool to 4°C. Add sodium thiosulfate if residual chlorine, 7 days with pH > 2, 14 days with pH ≤ 28.	8260B 8260C	40 mL glass, VOA vial (in triplicate) with Teflon®-lined septa without headspace. Cool to 4°C. Add sodium thiosulfate if residual chlorine, 1:1 HCl to pH ≤ 2, 14 days with pH ≤ 29.
	Solid5	5 g or 25 g	--	N/A	8260B 8260C	4 or 8 oz. glass with Teflon®-lined lid. Cool to 4 °C, 14 days. Field preserved with sodium bisulfate solution for low level analysis, or with methanol for medium level analysis. Soil sample can also be taken by using the EnCoreTM sampler and preserved in the lab within 48 hrs. of sampling. Maximum holding time for EnCoreTM sampler is 48 hrs. (before the sample is added to methanol or sodium bisulfate). Cool to 4°C(12)
	Waste	5 g or 25 g	--	N/A	8260B 8260C	4 or 8 oz. glass with Teflon®-lined lid, Cool 4 °C, 14 days. Field preserved with sodium bisulfate solution for low level analysis, or with methanol for medium level analysis. Soil sample can also be taken by using the EnCoreTM sampler and preserved in the lab within 48 hrs of sampling. Maximum holding time for EncoreTM sampler is 48 hrs. (before sample is added to methanol or sodium bisulfate). Cool to 4°C12

Footnotes

1 *Minimum sample size indicates sample amount needed for a single analysis. Matrix spikes or duplicates will require an additional sample amount of at least this amount for each additional QC sample aliquot required.*

2 *National Pollutant Discharge Elimination System - 40 CFR Part 136, Appendix A.*

3 *Holding times are calculated from the date of collection.*

4 *Resource Conservation and Recovery Act, Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, Third Edition, September 1986. Contains Final Update I (July 1992), Final Update IIA (August 1993), Final Update II (September 1994), Final Update IIB (January 1995), and Final Update III (December 1996).*

5 *Solid matrix type includes soil, sediment, sludge or other solids not classified as waste.*

6 *Only one determination method is listed when separate methods are required for preparation and analysis.*

7 *Method 1664 was promulgated by the EPA with an effective date of June 14, 1999.*

8 *For acrolein and acrylonitrile the pH should be adjusted to 4-5. This pH adjustment is not required if acrolein is not measured. Samples requiring analysis of acrolein that received no pH adjustment must be analyzed within three days of sampling.*

9 *For acrolein and acrylonitrile the pH should be adjusted to 4-5.*

10 *Method not listed in 40 CFR Part 136.*

11 *Should only be used in the presence of residual chlorine.*

12 *Depending on regulatory programs, EnCore® samplers may be preserved for up to 14 days from sampling by freezing at -5 to-12°C until analysis. Alternatively the EnCore® sample may be transferred to a 40-ml VOA vial and preserved by freezing at -5 to -12°C until analysis. Some regulatory agencies may require 4 or 8 oz glass with Teflon®-lined lid, Cool 4°C, 14 days. This technique is not recommended, but will be supported where required. (Preservation and holding times are subject to client specifications.)*

Table 22-3. Sample Containers, Preservatives, and Holding Times for TCLP1 and SPLP2

Analytical Parameters	Matrix	Minimum Sample Size	TCLP Method 1311 and SPLP Method 1312 Requirements	
			From Field Collection to TCLP/SPLP Extraction	From TCLP/SPLP Extraction to Analysis
Mercury	Liquid Solid Waste	1L	1L glass, Cool, 4°C, 28 days	Glass or polyethylene 28 days
Metals (except mercury)	Liquid Solid Waste	1L	1L glass, Cool, 4°C, 180 days	Glass or polyethylene 180 days
Semivolatiles	Liquid Solid Waste	1L	1L glass, Cool 4°C, 14 days	1L glass Extraction of leachate within 7 days of TCLP extraction, Analyze extract within 40 days
Volatiles	Liquid Solid Waste	6 oz	4 oz glass, Cool 4°C, 14 days	40 mL glass, 14 days

Footnotes

TCLP = Toxicity Characteristic Leaching Procedure
SPLP = Synthetic Precipitation Leaching Procedure

23. HANDLING OF SAMPLES

23.1. Sample management procedures at the laboratory ensure that sample integrity and custody are maintained and documented from sampling/receipt through disposal.

23.2. Chain of Custody (COC)

23.2.1. The COC form is the written documented history of any sample and is initiated when bottles are sent to the field, or at the time of sampling. This form is completed by the Sampling personnel and accompanies the samples to the laboratory where it is received and stored under the laboratory's custody. The purpose of the COC form is to provide a legal written record of the handling of samples from the time of collection until they are received at the laboratory. It also serves as the primary written request for analyses from the client to the laboratory. The COC form acts as a purchase order for analytical services when no other contractual agreement is in effect. An example of a COC form may be found in Figure 23-1.

23.3. Field Documentation

23.3.1. The information the sampler needs to provide at the time of sampling on the container label is:

23.3.1.1. Sample identification

23.3.1.2. Date and time

23.3.1.3. Preservative

23.3.2. During the sampling process, the COC form is completed and must be legible (see Figure 23-1). This form includes information such as:

23.3.2.1. Client name, address, phone number and fax number (if available)

23.3.2.2. Project name and/or number

23.3.2.3. The sample identification

23.3.2.4. Date, time, and location of sampling

23.3.2.5. Sample collectors name

23.3.2.6. The matrix description

23.3.2.7. The container description

23.3.2.8. The total number of each type of container

23.3.2.9. Preservatives used

23.3.2.10. Analysis requested

23.3.2.11. Requested turnaround time (TAT)

23.3.2.12. Any special instructions

23.3.2.13. Purchase Order number or billing information (e.g. quote number) if available

23.3.2.14. The date and time that each person received or relinquished the sample(s), including their signed name.

23.3.3. When the sampling personnel deliver the samples directly to TestAmerica personnel, the samples are stored in a cooler with ice, as applicable, and remain solely in the possession of the client's Field technician until the samples are delivered to the laboratory personnel. The sample collector must assure each container is in his/her physical possession or in his/her view at all times, or stored in such a place and manner to preclude tampering. The field technician relinquishes the samples in writing on the COC form to the Sample Control personnel at the laboratory or to a TestAmerica courier. When sampling personnel deliver the samples through a common carrier (FedEx, UPS), the COC relinquished date/time is completed by the Field personnel; and samples are released to the carrier. Samples are only considered to be received by lab when personnel at the fixed laboratory facility have physical contact with the samples.

Note: Independent couriers are not required to sign the COC form. The COC is usually kept in the sealed sample cooler. The COC is stored with project information and the report.

23.4. Legal / Evidentiary Chain-of-Custody

23.4.1. The lab does not accept samples that require legal Chain-of-Custody.

23.5. Sample Receipt

23.5.1. Samples are received at the laboratory by designated Sample Receiving personnel, and a unique laboratory project identification number is assigned. Each sample container must be assigned a unique sample identification number that is cross-referenced to the client identification number such that traceability of test samples is unambiguous and documented. Each sample container is affixed with a durable sample identification label. Sample acceptance, receipt, tracking, and storage procedures are summarized in the following sections. SOP NC-SC-005, Sample Receiving and Sample Control, describes the laboratory's sample receipt procedure.

23.5.2. Per State and/or Federal Regulation, the client is responsible to ensure that samples are shipped in accordance with DOT/IATA requirements, and that radioactive materials may only be delivered to licensed facilities. Any samples containing (or suspected to contain) Source, Byproduct, or special Nuclear Material, as defined by 20 CFR should be delivered directly to facilities licensed to handle such radioactive material. Natural material or ores containing naturally occurring radionuclides may be delivered to any TestAmerica facility or courier as long as the activity concentration of the material does not exceed 270 pCi/g alpha or 2700 pCi/g beta (49CFRPart173).

23.6. Laboratory Receipt

23.6.1. Samples must be received and logged in at TestAmerica by a designated sample custodian or other properly trained associate. Upon sample receipt, the sample custodian shall, as appropriate:

23.6.1.1. Wear appropriate personal protective equipment. At a minimum, this consists of cut-resistant gloves, a lab coat, and safety glasses

23.6.1.2. Examine the shipping containers to verify that the custody tape is intact

23.6.1.3. Examine all sample containers for damage

23.6.1.4. Open shipping containers in adequately ventilated areas to assure worker safety

23.6.1.5. Determine if the temperature required by the requested testing program has been maintained during shipment. Document the shipping container temperature on the Cooler Receipt Form

23.6.1.6. Compare samples received against those listed on the COC

23.6.1.7. Verify that sample holding times have not been exceeded

23.6.1.8. Examine all shipping records for accuracy and completeness

23.6.1.9. Determine sample pH (if required for the scheduled analysis) (except VOA and TOX samples) and record on the Cooler Receipt Form (CRF)

23.6.1.10. Sign and date the COC immediately (only after shipment is accepted) and attach the waybill

23.6.1.11. Note any problems associated with the coolers and samples on the cooler receipt form and notify the PM who in turn notifies the client

23.6.1.12. Attach durable (water-resistant) laboratory sample container labels with unique laboratory identification number and test

23.6.1.13. Place the samples in proper laboratory storage.

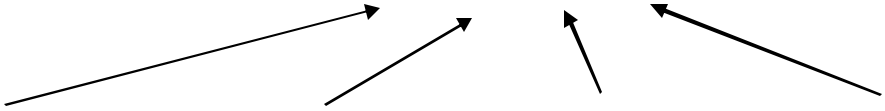
23.6.2. A Cooler Receipt Form (CRF) or an equivalent form/system is generated by sample control during the sample log-in process to document anomalies identified upon the receipt of samples in the laboratory. These anomalies are outside of laboratory control and do not require corrective actions to be taken within the laboratory. The affected client must be notified by the PM or designee of all issues generated for their samples. The PM is responsible for resolving with the client how to proceed with the samples and documenting the decision to proceed with the analysis of compromised samples. Issues must be resolved prior to sample preparation and analysis. The completed CRF must be stored in the project file. An example CRF is shown in Figure 24-4. The report narrative must include an explanation of sample receiving related anomalies.

23.7. Unique Sample Identification

23.7.1. All samples that are processed through the laboratory receive a unique sample identification to ensure that there can be no confusion regarding the identity of such samples at any time. This system includes identification for all samples, subsamples and subsequent extracts and/or digestates.

23.7.2. The laboratory assigns a unique identification (e.g., Sample ID) code to each sample container received at the laboratory. This Primary ID is made up of the following information (consisting of 4 components):

Example: XXX - 9608 - A - 1



Location ID (3-digit # for your lab) | Login ID | Container Occurrence | Sample Number

23.7.3. The above example states that TestAmerica <location> Laboratory (Location XXX). Login ID is 9608 (unique to a particular client/job occurrence). The container code indicates it is the first container (“A”) of Sample #1.

23.7.4. If the primary container goes through a prep step that creates a “new” container, then the new container is considered secondary and gets another ID. An example of this being a client sample in a 1-Liter amber bottle is sent through a Liquid/Liquid Extraction and an extraction vial is created from this step. The vial would be a SECONDARY container. The secondary ID has 5 components.

Example: XXX - 9608 - A - 1 - A ← Secondary Container Occurrence

23.7.5. Example: 220-9608-A-1-A, would indicate the PRIMARY container listed above that went through a step that created the 1st occurrence of a Secondary container.

23.7.6. With this system, a client sample can literally be tracked throughout the laboratory in every step from receipt to disposal.

23.8. Sample Acceptance Policy

23.8.1. The laboratory has a written sample acceptance policy outlined in SOP NC-SC-005, Sample Receiving and Sample Control, that clearly outlines the circumstances under which samples must be accepted or rejected. These include:

23.8.1.1. A COC filled out completely

23.8.1.2. Samples must be properly labeled

23.8.1.3. Proper sample containers with adequate volume for the analysis and necessary QC

23.8.1.4. Samples must be preserved according to the requirements of the requested analytical method

23.8.1.5. Sample holding times must be adhered to

23.8.1.6. All samples submitted for water/solid Volatile Organic analyses must have a Trip Blank submitted at the same time

23.8.2. The Project Manager must be notified if any sample is received in damaged condition.

23.8.3. Data from samples which do not meet these criteria are flagged and the nature of the variation from policy is defined.

23.8.4. Once sample acceptance is verified, the samples are logged into LIMS according to SOP NC-SC-005.

23.9. Sample Storage

23.9.1. In order to avoid deterioration, contamination or damage to a sample during storage and handling, from the time of receipt until all analyses are complete, samples are stored in refrigerators, freezers, or protected locations suitable for the sample matrix. Metals samples may be unrefrigerated. In addition, samples to be analyzed for volatile organic parameters are stored in separate refrigerators designated for volatile organic parameters only. Samples are never to be stored with reagents, standards, or materials that may create contamination.

23.9.2. To ensure the integrity of the samples during storage, refrigerator blanks are maintained in the volatile sample refrigerators and analyzed every week.

23.9.3. Analysts and technicians retrieve the sample container allocated to their analysis from the designated refrigerator and place them on carts, analyze the sample, and return the remaining sample or empty container to the refrigerator from which it originally came. All unused portions of samples, including empty sample containers, are returned to the secure sample control area. All samples are kept in the refrigerators for a minimum of 30 days after report generation, which meets or exceeds most sample holding times. After this time period, the samples are removed from the refrigerator shelves and prepared for disposal. Special arrangements may be made to store samples for longer periods of time.

23.9.4. Access to the laboratory is controlled such that sample storage need not be locked at all times unless a project specifically demands it. Samples are accessible to laboratory personnel only. Visitors to the laboratory are prohibited from entering the refrigerator and laboratory areas unless accompanied by an employee of TestAmerica.

23.10. Hazardous Samples And Foreign Soils

23.10.1. All samples per SOP are treated as hazardous. If any extra or known hazards are present in the sample, the sample is flagged and precautions / instructions are put in the comments. Hazardous samples are segregated out, and go into the waste stream profile for the nature of the hazard. All soils--foreign and domestic--go to a USDA approved incinerator. See SOP NC-SC-019 Procedure of Acceptance and Handling of USDA Regulated Domestic and Foreign Soil for further information.

23.11. Sample Shipping

23.11.1. In the event the laboratory needs to ship samples, the samples are placed in a cooler with enough ice to ensure the samples remain just above freezing and at or below 6.0°C during transit. The samples are carefully surrounded by packing material to avoid breakage (yet

maintain appropriate temperature). A trip blank is enclosed for those samples requiring water/solid volatile organic analyses. The Chain-of-Custody form is signed by the Sample Control technician and attached to the shipping paperwork. Samples are generally shipped overnight express or hand-delivered by a TestAmerica courier to maintain sample integrity. All personnel involved with shipping and receiving samples must be trained to maintain the proper Chain-of-Custody documentation and to keep the samples intact and on ice. The Environmental, Health and Safety Manual contains additional shipping requirements.

Note: If a client does not request trip blank analysis on the COC or other paperwork, the laboratory will not analyze the trip blanks that were supplied. However, in the interest of good client service, the laboratory will advise the client at the time of sample receipt that it was noted that they did not request analysis of the trip blank; and that the laboratory is providing the notification to verify that they are not inadvertently omitting a key part of regulatory compliance testing.

23.12. Sample Disposal

23.12.1. Samples should be retained for a minimum of 30 days after the project report is sent; however, provisions may be made for earlier disposal of samples once the holding time is exceeded. Some samples are required to be held for longer periods based on regulatory or client requirements (e.g., 60 days after project report is sent). The laboratory must follow the longer sample retention requirements where required by regulation or client agreement. Several possibilities for sample disposal exist--the sample may be consumed completely during analysis, the sample may be returned to the customer or location of sampling for disposal, or the sample may be disposed of in accordance with the laboratory's waste disposal procedures (SOP NC-SC-005, Sample Receiving and Sample Control). All procedures in the laboratory Environmental, Health and Safety Manual are followed during disposal. Samples are normally maintained in the laboratory no longer than two months from receipt unless otherwise requested. Unused portions of samples found or suspected to be hazardous according to state or federal guidelines may be returned to the client upon completion of the analytical work. Waste disposal complies with all federal and state laws and regulations.

23.12.2. If a sample is part of a known litigation, the affected legal authority, sample data user, and/or submitter of the sample must participate in the decision about the sample disposal. All documentation and correspondence concerning the disposal decision process must be kept on file. Pertinent information includes the date of disposal, nature of disposal (such as sample depletion, hazardous waste facility disposal, return to client), and names of individuals who conducted the arrangements and physically completed the task. Sample labels are destroyed through the disposal method, e.g., samples are incinerated. A Waste Manifest is completed.

Figure 23-1. Example: Chain of Custody (COC)

TestAmerica North Canton
4101 Shuffle Drive N.W.
North Canton, OH 44720
phone 330-497-9396 fax 330-497-0772

Chain of Custody Record

Client Contact	Project Manager:	Site Contact:	Date:
Your Company Name here	Tel/Fax:	Lab Contact:	Carrier:
Address	Analysis Turnaround Time		
City/State/Zip	Calendar (C) or Work Days (W)		
(xxx) xxx-xxxx Phone	TAT if different from Below		
(xxx) xxx-xxxx FAX	☐ 2 weeks		
Project Name:	☐ 1 week		
Site:	☐ 2 days		
P O #	☐ 1 day		

Sample Identification	Sample Date	Sample Time	Sample Type	Matrix	# of Cont.	Filtered Sample																	

Preservation Used: 1= Ice, 2= HCl; 3= H2SO4; 4=HNO3; 5=NaOH; 6= Other _____

Possible Hazard Identification
☐ *Non-Hazard* ☐ *Flammable* ☐ *Skin Irritant* ☐ *Poison B* ☐ *Unknown*

Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)
☐ *Return To Client* ☐ *Disposal By Lab* ☐ *Archive For _____ Months*

Special Instructions/QC Requirements & Comments:

Relinquished by:	Company:	Date/Time:	Received by:	Company:
Relinquished by:	Company:	Date/Time:	Received by:	Company:
Relinquished by:	Company:	Date/Time:	Received by:	Company:

Figure 23-2.

Example: Custody Seal

Figure 23-3. Example: Internal Chain of Custody (COC)

TestAmerica Laboratories, Inc.

Sample Control Record

Client:

Lot Number:

Case Number/SDG:

Storage Location:

Laboratory Sample ID	Transferred By	Date	Entered	Removed	Reason

Figure 23-4. Example: Cooler Receipt Form

TestAmerica North Canton Sample Receipt Form/Narrative Login # :_____

Client Site Name_____ By:_____

Cooler Received on _____ Opened on_____ (Signature)

FedEx: 1st Grd Exp UPS FAS Stetson Client Drop Off TestAmerica Courier Other_____

TestAmerica Cooler # _____ Foam Box Client Cooler Box Other _____

Packing material used: Bubble Wrap Foam Plastic Bag None Other _____

COOLANT: Wet Ice Blue Ice Dry Ice Water None

1. Cooler temperature upon receipt

IR GUN# 1 (CF -2ºC) Observed Sample Temp._____ºC Corrected Sample Temp._____ºC

IR GUN# 4G (CF -1ºC) Observed Sample Temp._____ºC Corrected Sample Temp._____ºC ÿ

IR GUN# 5G (CF -1ºC) Observed Sample Temp._____ºC Corrected Sample Temp._____ºC

IR GUN# 6Y (CF -2ºC) Observed Sample Temp._____ºC Corrected Sample Temp._____ºC

2. Were custody seals on the outside of the cooler(s)? If Yes Yes No

-Were custody seals on the outside of the cooler(s) signed & dated? Yes No NA

-Were custody seals on the bottle(s)? Yes No

3. Shippers' packing slip attached to the cooler(s)? Yes No

4. Did custody papers accompany the sample(s)? Yes No

5. Were the custody papers relinquished & signed in the appropriate place? Yes No

6. Did all bottles arrive in good condition (Unbroken)? Yes No

7. Could all bottle labels be reconciled with the COC? Yes No

8. Were correct bottle(s) used for the test(s) indicated? Yes No

9. Sufficient quantity received to perform indicated analyses? Yes No

10. Were sample(s) at the correct pH upon receipt? Yes No NA

11. Were VOAs on the COC? Yes No

12. Were air bubbles >6 mm in any VOA vials? Yes No NA

13. Was a trip blank present in the cooler(s)? Yes No

Contacted PM _____ Date _____ by _____ via Verbal Voice Mail Other

Concerning _____

14. CHAIN OF CUSTODY & SAMPLE DISCREPANCIES

15. SAMPLE CONDITION

Sample(s)_____were received after the recommended holding time had expired.

Sample(s)_____ were received in a broken container.

Sample(s)_____were received with bubble >6 mm in diameter. (Notify PM)

16. SAMPLE PRESERVATION

Sample(s) _____ were further preserved in Sample Receiving to meet recommended pH level(s). Nitric Acid Lot# 110410-HNO3; Sulfuric Acid Lot# 041911-H2SO4; Sodium Hydroxide Lot# 121809 -NaOH; Hydrochloric Acid Lot# 041911-HCl; Sodium Hydroxide and Zinc Acetate Lot# 100108-(CH3COO)2ZN/NaOH. What time was preservative added to sample(s)? _____

Client ID	pH	Date	Initials

Cooler #	Observed Sample Temp. ºC	Corrected Sample Temp. ºC	IR #	Coolant

24. ASSURING THE QUALITY OF TEST RESULTS

24.1. In order to assure our clients of the validity of their data, the laboratory continuously evaluates the quality of the analytical process. The analytical process is controlled not only by instrument calibration as discussed in Section 20, but also by routine process quality control measurements (e.g., Method Blanks, Laboratory Control Samples (LCS), Matrix Spikes (MS), duplicates (DUP), surrogates, Internal Standards (IS)). These quality control checks are performed as required by the method or regulations to assess precision and accuracy. Quality control samples are to be treated in the exact same manner as the associated field samples being tested. In addition to the routine process quality control samples, Proficiency Testing (PT) Samples (concentrations unknown to laboratory) are analyzed to help ensure laboratory performance.

24.2. Controls

24.2.1. Sample preparation or pre-treatment is commonly required before analysis. Typical preparation steps include homogenization, grinding, solvent extraction, sonication, acid digestion, distillation, reflux, evaporation, drying and ashing. During these pre-treatment steps, samples are arranged into discreet manageable groups referred to as preparation (prep) batches. Prep batches provide a means to control variability in sample treatment. Control samples are added to each prep batch to monitor method performance and are processed through the entire analytical procedure with investigative/field samples.

24.3. Negative Controls

Table 24-1. Example – Negative Controls

Control Type	Details
Method Blanks (MB)	are used to assess preparation and analysis for possible contamination during the preparation and processing steps.
	The specific frequency of use for method blanks during the analytical sequence is defined in the specific standard operating procedure for each analysis. Generally it is 1 for each batch of samples; not to exceed 20 environmental samples.
	The method blank is prepared from a clean matrix similar to that of the associated samples that is free from target analytes (e.g., Reagent water, Ottawa sand, glass beads, etc.) and is processed along with and under the same conditions as the associated samples. The method blank goes through all of the steps of the process (including as necessary: filtration, clean-ups, etc.).
	Re-analyze or quality-associated sample results when the concentration of a targeted analyte in the method blank is at, or above, the reporting limit as established by the method or by regulation, AND is greater than 1/20 of the amount measured in the sample.

Table 24-1. Example – Negative Controls

Control Type	Details
Calibration Blanks	are prepared and analyzed along with calibration standards where applicable or injected at specifed frequencies throughout an analytical sequence. They are prepared using the same reagents that are used to prepare the standards. In some analyses the calibration blank may be included in the calibration curve. These blanks may be termed Initial Calibration Blanks (ICB) or Continuing Calibration Blanks (CCB),
Instrument Blanks	are blank reagents or reagent water that may be processed during an analytical sequence in order to assess contamination in the analytical system. In general, instrument blanks are used to differentiate between contamination caused by the analytical system and that caused by the sample handling or sample prep process. Instrument blanks may also be inserted throughout the analytical sequence to minimize the effect of carryover from samples with high analyte content.
Trip Blanks 1	are required to be submitted by the client with each shipment of samples requiring aqueous and solid volatiles analyses (or as specified in the client's project plan). Additionally, trip blanks may be prepared and analyzed for volatile analysis of air samples, when required by the client. A trip blank may be purchased (certified clean) or is prepared by the laboratory by filling a clean container with pure deionized water that has been purged to remove any volatile compounds. Appropriate preservatives are also added to the container. The trip blank is sent with the bottle order and is intended to reflect the environment that the containers are subjected to throughout shipping and handling and help identify possible sources if contamination is found. The field sampler returns the trip blank in the cooler with the field samples.
Field Blanks 1	are sometimes used for specific projects by the field samplers. A field blank prepared in the field by filling a clean container with pure reagent water and appropriate preservative, if any, for the specific sampling activity being undertaken. (EPA OSWER)
Equipment Blanks 1	are also sometimes created in the field for specific projects. An equipment blank is a sample of analyte-free media which has been used to rinse common sampling equipment to check effectiveness of decontamination procedures. (TNI)
Holding Blanks	also referred to as refrigerator or freezer blanks, are used to monitor the sample storage units for volatile organic compounds during the storage of VOA samples in the laboratory

24.3.1. When known, these field QC samples should not be selected for matrix QC as it does not provide information on the behavior of the target compounds in the field samples. Usually, the client sample ID will provide information to identify the field blanks with labels such as "FB", "EB", or "TB."

24.3.2. Evaluation criteria and corrective action for these controls are defined in the specific standard operating procedure for each analysis.

24.4. Positive Controls

24.4.1. Control samples (e.g., QC indicators) are analyzed with each batch of samples to evaluate data based upon:

24.4.2. Method Performance [Laboratory Control Sample (LCS) or Blank Spike (BS)], which entails both the preparation and measurement steps

24.4.3. Matrix Effects (Matrix Spike (MS) or Sample Duplicate (MD, DUP), which evaluates field sampling accuracy, precision, representativeness, interferences, and the effect of the matrix on the method performed.

24.4.4. Each regulatory program and each method within those programs specify the control samples that are prepared and/or analyzed with a specific batch.

Note that frequency of control samples vary with specific regulatory, methodology, and project- specific criteria. Complete details on method control samples are as listed in each analytical SOP.

24.5. Method Performance Control - Laboratory Control Sample (LCS)

24.5.1. The LCS measures the accuracy of the method in a blank matrix and assesses method performance independent of potential field sample matrix affects in a laboratory batch.

24.5.2. The LCS is prepared from a clean matrix similar to that of the associated samples that is free from target analytes (for example: Reagent water, Ottawa sand, glass beads, etc.) and is processed along with and under the same conditions as the associated samples. The LCS is spiked with verified known amounts of analytes or is made of a material containing known and verified amounts of analytes, taken through all preparation and analysis steps along with the field samples. Where there is no preparation taken for an analysis (such as in aqueous volatiles), or when all samples and standards undergo the same preparation and analysis process (such as Phosphorus), a calibration verification standard is reported as the LCS. In some instances where there is no practical clean solid matrix available, aqueous LCS's may be processed for solid matrices; final results may be calculated as mg/kg or ug/kg, assuming 100% solids and a weight equivalent to the aliquot used for the corresponding field samples, to facilitate comparison with the field samples.

24.5.3. Certified pre-made reference material purchased from a NIST/A2LA accredited vendor may also be used for the LCS when the material represents the sample matrix or the analyte is not easily spiked (e.g., solid matrix LCS for metals, TDS, etc.).

24.5.4. The specific frequency of use for LCS during the analytical sequence is defined in the specific standard operating procedure for each analysis. It is generally one for each batch of sample--not to exceed 20 environmental samples.

24.5.5. If the mandated or requested test method, or project requirements, do not specify the spiking components, the laboratory shall spike all reportable components to be reported in the Laboratory Control Sample (and Matrix Spike) where applicable, e.g., no spike of pH. However, in cases where the components interfere with accurate assessment (such as simultaneously spiking chlordane, toxaphene and PCBs in Method 608),

the test method has an extremely long list of components or components are incompatible, at a minimum, a representative number of the listed components (see below) shall be used to control the test method. The selected components of each spiking mix shall represent all chemistries, elution patterns and masses, permit specified analytes and other client requested components. However, the laboratory shall ensure that all reported components are used in the spike mixture within a two-year time period.

24.5.6. For methods that have 1-10 target analytes, spike all components.

24.5.7. For methods that include 11-20 target analytes, spike at least 10 or 80%, whichever is greater.

24.5.8. For methods with more than 20 target analytes, spike at least 16 components.

24.5.9. Exception: Due to analyte incompatibility in pesticides, Toxaphene and Chlordane are only spiked at client request based on specific project needs.

24.5.10. Exception: Due to analyte incompatibility between the various PCB Aroclors, Aroclors 1016 and 1260 are used for spiking as they cover the range of all of the Aroclors. Specific Aroclors may be used by request on a project-specific basis.

24.6. Sample Matrix Controls

Table 24-2 Sample Matrix Control

Control Type	Details	
Matrix Spikes (MS)	Use	To assess the effect sample matrix of the spiked sample has on the precision and accuracy of the results generated by the method used;
	Typical Frequency 1	At a minimum, with each matrix-specific batch of samples processed, an MS is carried through the complete analytical procedure. Unless specified by the client, samples used for spiking are randomly selected and rotated between different client projects.If the mandated or requested test method does not specify the spiking components, the laboratory shall spike all reportable components to be reported in the Laboratory Control Sample and Matrix Spike. Refer to the method SOP for complete details
	Description	Essentially, a sample fortified with a known amount of the test analyte(s).
Surrogate	Use	Measures method performance to sample matrix (organics only).
	Typical Frequency 1	Are added to all samples, standards, and blanks, for all organic chromatography methods except when the matrix precludes its use or when a surrogate is not available. The recovery of the surrogates is compared to the control limits for the specific method. Poor surrogate recovery may indicate a problem with sample composition and shall be reported, with data qualifiers, to the client whose sample produced poor recovery.
	Description	Are similar to matrix spikes except the analytes are compounds with properties that mimic the analyte of interest and are unlikely to be found in environment samples.

Table 24-2 Sample Matrix Control

Control Type	Details	
Duplicates2	Use	For a measure of analytical precision, with each matrix-specific batch of samples processed, a matrix duplicate (MD or DUP) sample, matrix spike duplicate (MSD), or LCS duplicate (LCSD) is carried through the complete analytical procedure.
	Typical Frequency 1	Duplicate samples are usually analyzed with methods that do not require matrix spike analysis.
	Description	Performed by analyzing two aliquots of the same field sample independently or an additional LCS.
Internal Standards	Use	Are spiked into all environmental and quality control samples (including the initial calibration standards) to monitor the qualitative aspect of organic and some inorganic analytical measurements.
	Typical Frequency 1	All organic and ICP methods as required by the analytical method.
	Description	Used to correct for matrix effects and to help troubleshoot variability in analytical response and are assessed after data acquisition. Possible sources of poor internal standard response are sample matrix, poor analytical technique or instrument performance.

1 See the specific analytical SOP for type and frequency of sample matrix control samples.

2 LCSD's are normally not performed except when regulatory agencies or client specifications require them. The recoveries for the spiked duplicate samples must meet the same laboratory established recovery limits as the accuracy QC samples. If an LCSD is analyzed both the LCS and LCSD must meet the same recovery criteria and be included in the final report. The precision measurement is reported as "Relative Percent Difference" (RPD). Poor precision between duplicates (except LCS/LCSD) may indicate non-homogeneous matrix or sampling.

24.7. Control Limits

24.7.1. As mandated by the test method and regulation, each individual analyte in the LCS, MS, or Surrogate Spike is evaluated against the control limits published in the test method. Where there are no established acceptance criteria, the laboratory calculates in-house control limits with the use of control charts or, in some cases, utilizes client project-specific control limits. When this occurs, the regulatory or project limits will supersede the laboratory's in-house limits.

Note: For methods, analytes, and matrices with very limited data (e.g., unusual matrices not analyzed often), interim limits are established using available data or by analogy to similar methods or matrices.

Note: For Ohio VAP the laboratory must implement Corrective Action procedures to resolve the deviation and limit qualification of the final results. The laboratory is not permitted to deviate from its VAP approved SOP if it intends to attest under affidavit that the "results" are VAP certified. When all corrective actions listed in the SOP have been exhausted, it may be necessary to use technical judgment in which case the decision process and rationale will be presented in the final report

and/or affidavit and the data will be noted as 'not VAP certified' on the affidavit.

24.7.2. Once control limits have been established, they are verified, reviewed, and updated if necessary on an annual basis unless the method requires more frequent updating. Control limits are established per method (as opposed to per instrument) regardless of the number of instruments utilized.

24.7.3. Laboratory-generated Percent Recovery acceptance (control) limits are generally established by taking +3 Standard Deviations (99% confidence level) from the average recovery of a minimum of 20-30 data points (more points are preferred).

24.7.4. Regardless of the calculated limit, the limit should be no tighter than the Calibration Verification (ICV/CCV), (unless the analytical method specifies a tighter limit).

24.7.5. In-house limits cannot be any wider than those mandated in a regulated analytical method. Client or contract required control limits are evaluated against the laboratory's statistically derived control limits to determine if the data quality objectives (DQOs) an be achieved. If laboratory control limits are not consistent with DQOs, then alternatives must be considered, such as method improvements or use of an alternate analytical method.

24.7.6. The lowest acceptable recovery limit will be 10% (the analyte must be detectable and identifiable). Exception: The lowest acceptable recovery limit for Benzidine will be 5%, and the analyte must be detectable and identifiable.

24.7.7. The maximum acceptable recovery limit will be 200%.

24.7.8. The maximum acceptable RPD limit will be 30% for organic methods and 20% for inorganic methods. The minimum RPD limit is 10%.

24.7.9. If either the high or low end of the control limit changes by < 10% from previous, the control chart is visually inspected and, using professional judgment, they may be left unchanged if there is no affect on laboratory ability to meet the existing limits.

24.7.10. The lab must be able to generate a current listing of their control limits and track when the updates are performed. In addition, the laboratory must be able to recreate historical control limits. Refer to NC-QA-018, Statistical Evaluation of Data and Development of Control Charts, for details.

24.7.11. An LCS that is within the acceptance criteria establishes that the analytical system is in control and is used to validate the process. Samples that are analyzed with an LCS with recoveries outside of the control limits may be determined as out of control and should be re-analyzed if possible. If re-analysis is not possible, then the results for all affected analytes for samples within the same batch must be qualified when reported. The internal Corrective Action process (see Section 12) is also initiated if an LCS exceeds the control limits. Sample results may be qualified and reported without re-analysis if:

24.7.12. The analyte results are below the reporting limit and the LCS is above the upper control limit.

24.7.13. If the analytical results are above the relevant regulatory limit and the LCS is below the lower control limit.

Note: For Ohio VAP the laboratory must implement Corrective Action procedures to resolve the deviation and limit qualification of the final results. The laboratory is not permitted to deviate from its VAP approved SOP if it intends to attest under affidavit that the "results" are VAP certified. When all corrective actions listed in the SOP have been exhausted, it may be necessary to use technical judgment in which case the decision process and rationale will be presented in the final report and/or affidavit and the data will be noted as ‘not VAP certified’ on the affidavit.

24.7.14. Or, Department Of Defense (DOD) work, there are an allowable number of Marginal Exceedances (ME):

<11 analytes	0 marginal exceedances are allowed.
11 – 30 Analytes	1 marginal exceedance is allowed
31-50 Analytes	2 marginal exceedances are allowed
51-70 Analytes	3 marginal exceedances are allowed
71-90 Analytes	4 marginal exceedances are allowed
> 90 Analytes	5 marginal exceedances are allowed

24.7.15. Marginal exceedances are recovery exceedances between 3 SD and 4 SD from the mean recovery limit ().

Note: Use of Marginal Exceedances is not permitted for Ohio VAP.

24.7.16. Marginal exceedances must be random. If the same analyte exceeds the LCS control limit repeatedly, it is an indication of a systematic problem. The source of the error must be located and corrective action taken. The laboratory has a system to monitor marginal exceedances to ensure that they are random.

24.7.17. Though marginal exceedances may be allowed, the data must still be qualified to indicate it is outside of the normal limits.

24.7.18. If the MS/MSDs do not meet control limits, the MS/MSD and the associated spiked sample is reported with a qualifier for those analytes that do not meet limits. If obvious preparation errors are suspected, or if requested by the client, unacceptable MS/MSDs are reprocessed and re-analyzed to prove matrix interference. A more detailed discussion of acceptance criteria and corrective action can be found in the lab's method SOPs and in Section 12.

24.7.19. If a surrogate standard falls outside the control limits, and if there is not obvious chromatographic matrix interference, re-analyze the sample to confirm a possible matrix effect. If the recoveries confirm or there was obvious chromatographic interference, results are reported from the original analysis and a qualifier is added. If the re-analysis meets surrogate recovery criteria, the second run is reported (or both are reported if requested by the client).

Note: A more detailed discussion of acceptance criteria and corrective action can be found in the laboratory's method SOPs and in Section 12.

24.8. Additional Procedures To Assure Quality Control

24.8.1. The laboratory has written and approved method SOPs to assure the accuracy of the test method including calibration (see Section 20), use of certified reference materials (see Section 21), and use of PT samples (see Section 15).

24.8.2. A discussion regarding MDLs, Limit of Detection (LOD), and Limit of Quantitation (LOQ) can be found in Section 19.

24.8.3. Use of formulae to reduce data is discussed in the method SOPs and in Section 20.

24.8.4. Selection of appropriate reagents and standards is included in Sections 9 and 21.

24.8.5. A discussion on selectivity of the test is included in Section 5.

24.8.6. Constant and consistent test conditions are discussed in Section 18.

24.8.7. The laboratory sample acceptance policy is included in Section 23.

25. REPORTING RESULTS

25.1. The results of each test are reported accurately, clearly, unambiguously, and objectively in accordance with State and Federal regulations as well as client requirements. Analytical results are issued in a format that is intended to satisfy customer and laboratory accreditation requirements as well as provide the end user with the information needed to properly evaluate the results. Where there is a conflict between client requests and laboratory ethics or regulatory requirements, the laboratory's ethical and legal requirements are paramount, and the laboratory must work with the client during project setup to develop an acceptable solution. Refer to Section 7.

25.2. A variety of report formats are available to meet specific needs.

25.3. In cases where a client asks for simplified reports, there must be a written request from the client. There still must be enough information that would show any analyses that were out of conformance (QC out of limits) and there should be a reference to a full report that is made available to the client.

25.4. Review of reported data is included in Section 19.

25.5. Test Reports

25.5.1. Analytical results are reported in a format that is satisfactory to the client and meets all requirements of applicable accrediting authorities and agencies. A variety of report formats are available to meet specific needs. The report is printed, reviewed, and signed by the appropriate Project Manager. At a minimum, the standard laboratory report shall contain the following information:

25.5.1.1. A report title with a "Sample Result" header.

25.5.1.2. Each report cover page printed, which includes the laboratory name, address, and telephone number.

25.5.1.3. A unique identification of the report (e.g., Work Order number) and on each page an identification in order to ensure the page is recognized as part of the report and a clear identification of the end.

25.5.1.4. Page numbers of report are represented at the bottom of each page. The report is sequentially paginated. The final page of the report is labeled as "End of Report".

25.5.1.5. A copy of the Chain-of-Custody (COC).

25.5.1.6. Any COCs involved with subcontracting are included.

25.5.1.7. Any additional addenda to the report must be treated in a similar fashion so it is a recognizable part of the report and cannot

accidentally get separated from the report (e.g., Sampling information).

25.5.1.8. The name and address of client and a project name/number, if applicable.

25.5.1.9. Client project manager or other contact

25.5.1.10. Description and unambiguous identification of the tested sample(s) including the client identification code.

25.5.1.11. Date of receipt of sample, date and time of collection, and date(s) of test preparation and performance, and time of preparation or analysis.

25.5.1.12. Date reported or date of revision, if applicable

25.5.1.13. Method of analysis including method code (EPA, Standard Methods, etc)

25.5.1.14. Certification Summary report, where required, will document that unless otherwise noted, all analytes tested and reported by the laboratory were covered by the noted certifications.

25.5.1.15. Reporting limit

25.5.1.16. Method detection limits (if requested)

25.5.1.17. Definition of data qualifiers and reporting acronyms, e.g., ND

25.5.1.18. Sample results

25.5.1.19. QC data consisting of method blank, surrogate, LCS, and MS/MSD recoveries and control limits

25.5.1.20. Condition of samples at receipt including temperature. This may be accomplished in a narrative or by attaching sample login sheets (refer to Section 25.2.4 – Item 3, regarding additional addenda).

25.5.1.21. A statement to the effect that the results relate only to the items tested and the sample as received by the laboratory.

25.5.1.22. A statement that the report shall not be reproduced except in full, without prior express written approval by the laboratory coordinator.

25.5.1.23. A signature and title of the person(s) accepting responsibility for the content of the report and date of issue. Signatories are appointed by the Lab Director.

25.5.1.24. When TNI accreditation is required, the lab must certify that the test results meet all requirements of TNI or provide reasons and/or justification if they do not.

25.5.1.25. The laboratory includes a cover page.

25.5.1.26. Where applicable, a narrative to the report that explains the issue(s) and corrective action(s) taken in the event that a specific accreditation or certification requirement was not met.

25.5.1.27. When soil samples are analyzed, a specific identification as to whether soils are reported on a “wet weight” or “dry weight” basis.

25.5.1.28. Appropriate laboratory certification number for the state of origin of the sample, if applicable.

25.5.2. If only part of the report is provided to the client (client requests some results before all of it is complete), it must be clearly indicated on the report, e.g., partial report, or how your lab identifies it. A complete report must be sent once all of the work has been completed.

25.5.3. Any non-TestAmerica subcontracted analysis results are provided as a separate report on the official letterhead of the subcontractor. All TestAmerica subcontracting is clearly identified on the report as to which laboratory performed a specific analysis.

25.5.4. A clear statement notifying the client that non-accredited tests were performed and directing the client to the laboratory’s accreditation certificates of approval shall be provided when non-accredited tests are included in the report.

Note: Refer to the Corporate SOP on Electronic Reporting and Signature Policy CA-L-P-002 for details on internally applying electronic signatures of approval.

25.5.5. Reports for Ohio VAP work require a VAP affidavit be completed and included with the report. One affidavit can be provided for multiple reports for a project.

Note: For additional information on Ohio VAP affidavits refer to OAC Rule 3745-300-04 and OAC Rule 3745-300-13(N), effective March 1, 2009.

25.6. Reporting Level or Report Type

25.6.1. The laboratory offers two levels of quality control reporting. Each level, in addition to its own specific requirements, contains all the information provided in the preceding level. The packages provide the following information in addition to the information described above:

25.6.2. Level I is a report with the features described in Section 25.2 above.

25.6.3. Level II is a Level I report plus summary information, including results for the method blank reported to the laboratory MDL, percent recovery for laboratory control samples and matrix spike samples, and the RPD values for all MSD and sample duplicate analyses.

25.6.4. Level III contains all the information supplied in Level II, but presented on the CLP-like summary forms, and relevant calibration information. A Level II report is not included, unless specifically requested. No raw data is provided.

25.6.5. Level IV is the same as Level III with the addition of all raw supporting data. In addition to the various levels of QC packaging, the laboratory also provides reports in diskette deliverable form. Procedures used to ensure client confidentiality are outlined in Section 25.7.

25.7. Electronic Data Deliverables (EDDs)

25.7.1. EDDs are routinely offered as part of TestAmerica services. TestAmerica Canton offers a variety of EDD formats including (but not limited to) ADR, EQuIS, GISKey, Region 5, NJHAZsite, and a wide variety of client specific multi-file, Excel and flat file formats.

25.7.2. EDD specifications are submitted to the IT Department by the PM for review and undergo the contract review process. Once the facility has committed to providing data in a specific electronic format, the coding of the format may need to be performed. This coding is documented and validated. The validation of the code is retained by the IT staff coding the EDD.

25.7.3. EDDs must be subject to a review to ensure their accuracy and completeness. If EDD generation is automated, review may be reduced to periodic screening if the laboratory can demonstrate that it can routinely generate that EDD without errors. Any revisions to the EDD format must be reviewed until it is demonstrated that it can routinely be generated without errors. If the EDD can be reproduced accurately and if all subsequent EDDs can be produced error-free, each EDD does not necessarily require a review.

25.8. Supplemental Information For Test

25.8.1. The lab identifies any unacceptable QC analyses or any other unusual circumstances or observations such as environmental conditions and any non-standard conditions that may have affected the quality of a result. This is typically in the form of a footnote or a qualifier and/or a narrative explaining the discrepancy in the front of the report.

25.8.2. 25.4.1 Numeric results with values outside of the calibration range, either high or low are qualified as 'estimated'.

25.8.3. 25.4.2 Where quality system requirements are not met, a statement of compliance/non-compliance with requirements and/or specifications is required, including identification of test results derived from any sample that did not meet TNI sample acceptance requirements such as improper container, holding time, or temperature.

25.8.4. 25.4.3 Where applicable, a statement on the estimated uncertainty of measurements; information on uncertainty is needed when a client's instructions so require.

25.8.5. 25.4.4 Opinions and Interpretations - The test report contains objective information, and generally does not contain subjective information such as opinions and interpretations. If such information is required by the client, the Laboratory Director will determine if a response can be prepared. If so, the Laboratory Director will designate the appropriate member of the management team to prepare a response. The response must be fully documented, and reviewed by the Laboratory Director, before release to the client. There may be additional fees charged to the client at this time, as this is a non-routine function of the laboratory.

25.8.6. When opinions or interpretations are included in the report, the laboratory provides an explanation as to the basis upon which the opinions and interpretations have been made. Opinions and interpretations are clearly noted as such and where applicable, a comment should be added suggesting that the client verify the opinion or interpretation with their regulator.

25.9. Environmental Testing Obtained From Subcontractors

25.9.1. If the laboratory is not able to provide the client the requested analysis, the samples would be subcontracted following the procedures outlined in the Corporate SOP CA-L-S-002, Subcontracting.

25.9.2. Data reported from analyses performed by a subcontractor laboratory are clearly identified as such on the analytical report provided to the client. Results from a subcontract laboratory outside of the TestAmerica network are reported to the client on the subcontract laboratory's original report stationary and the report includes any accompanying documentation.

25.10. Client Confidentiality

25.10.1. In situations involving the transmission of environmental test results by telephone, facsimile, or other electronic means, client confidentiality must be maintained.

25.10.2. TestAmerica will not intentionally divulge to any person (other than the client or any other person designated by the client in writing) any information regarding the services provided by TestAmerica or any

information disclosed to TestAmerica by the client. Furthermore, information known to be potentially endangering to national security or an entity's proprietary rights will not be released.

Note: This shall not apply to the extent that the information is required to be disclosed by TestAmerica under the compulsion of legal process. TestAmerica will, to the extent feasible, provide reasonable notice to the client before disclosing the information.

Note: Authorized representatives of an accrediting authority are permitted to make copies of any analyses or records relevant to the accreditation process, and copies may be removed from the laboratory for purposes of assessment.

25.10.3. Report deliverable formats are discussed with each new client. If a client requests that reports be faxed or e-mailed, the reports are faxed with a cover sheet or e-mailed with the following note that includes a confidentiality statement similar to the following:

25.10.4. "Confidentiality Notice: The information contained in this message is intended only for the use of the addressee, and may be confidential and/or privileged. If the reader of this message is not the intended recipient, or the employee or agent responsible to deliver it to the intended recipient, you are hereby notified that any dissemination, distribution or copying of this communication is strictly prohibited. If you have received this communication in error, please notify the sender immediately."

25.11. Format Of Reports

25.11.1. The format of reports is designed to accommodate each type of environmental test carried out and to minimize the possibility of misunderstanding or misuse.

25.12. Amendments To Test Reports

25.12.1. Corrections, additions, or deletions to reports are only made when justification arises through supplemental documentation. Justification is documented using the laboratory's corrective action system (refer to Section 12).

25.12.2. When the report is re-issued, a notation of "report reissue" is placed on the cover/signature page of the report or at the top of the narrative page with a brief explanation of reason for the reissue and a reference back to the lst final report generated.

25.13. Policies On Client Requests For Amendments

25.13.1. Policy on Data Omissions or Reporting Limit Increases

25.13.2. Fundamentally, our policy is simply to not omit previously reported results (including data qualifiers) or to not raise reporting limits and report sample results as ND. This policy has few exceptions. Exceptions are:

25.13.2.1. Laboratory error

25.13.2.2. Sample identification is indeterminate (confusion between COC and sample labels).

25.13.2.3. An incorrect analysis (not analyte) was requested (e.g., COC lists 8315 but client wanted 8310). A written request for the change is required.

25.13.2.4. Incorrect limits reported based on regulatory requirements

25.13.2.5. The requested change has absolutely no possible impact on the interpretation of the analytical results and there is no possibility of the change being interpreted as misrepresentation by anyone inside or outside of our company.

25.14. Multiple Reports

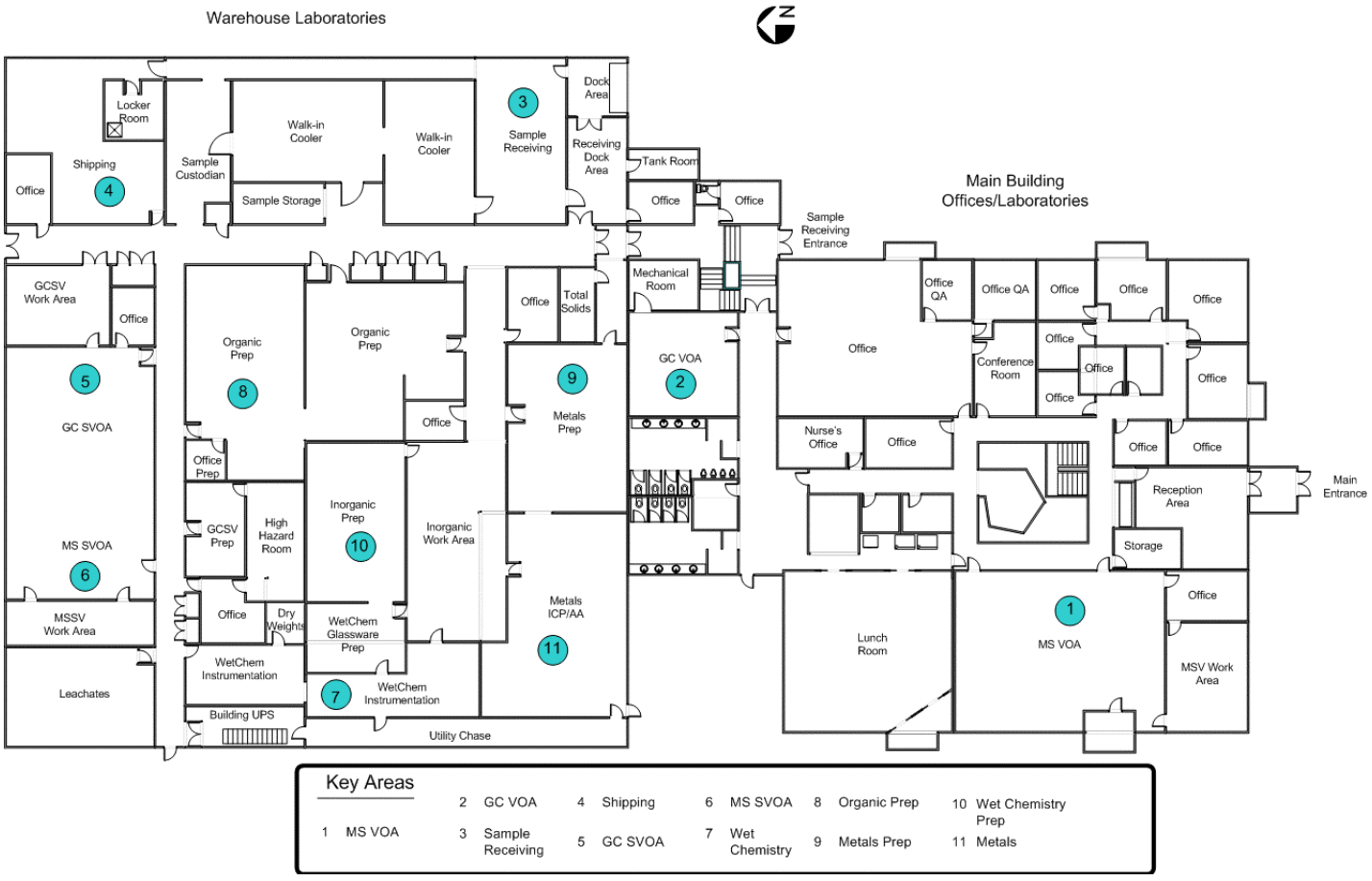
25.14.1. TestAmerica does not issue multiple reports for the same work order where there is different information on each report (this does not refer to copies of the same report) unless required to meet regulatory needs and approved by QA.

Appendix 1.

Laboratory Floor Plan

TestAmerica – North Canton

4101 Shuffel Dr NW
North Canton, OH 44720



Appendix 2. Laboratory Method Listing

Wet Chemistry Methods 1

Analytical Parameters	Matrix		Fields of Testing		
			CWA	RCRA (SW846)	Other
Alkalinity, Bicarbonate, Carbonate	Water		310.1. 2		SM 2320 B
				--	--
Biochemical Oxygen Demand, Carbonaceous	Water		EPA 405.1	--	SM 5210 B
Anions, Bromide, Chloride, Fluoride, Sulfate, Nitrite, Nitrate, ortho-phosphate	Water		EPA 300.0	EPA 9056A	--
	Waste		EPA 300.0	EPA 9056A	--
	Solid		EPA 300.0 (M)	EPA 9056A	--
Chemical Oxygen Demand	Water		EPA 410.4	--	SM 5220D
	Waste		EPA 410.4	--	--
Chloride	Water		EPA 325.22	EPA 9251	SM 4500 Cl-E
	Solid				--
Chromium, Hexavalent	Water		EPA 3500-Cr-B	EPA 7196A	SM 3500-Cr-B
	Waste		EPA 3500-Cr-B	EPA 7196A	SM 3500-Cr-B
	Solid		--	EPA 3060A EPA 7196A	--

1 Any matrix not listed is not applicable for the associated method
2 Removed from 40CFR

Analytical Parameters	Matrix	Fields of Testing			
			CWA	RCRA (SW846)	Other
Specific Conductance	Water		EPA 120.1	EPA 9050A	SM 2510B
	Waste		EPA 120.1	EPA 9050A	--
	Solid		--		--
Chlorine, Residual	Water		EPA 330.52	--	SM 4500 CL-G
Cyanide (Amenable)	Water		EPA 335.12	EPA 9012A, B	SM 4500 CN-G
	Solid		--	EPA 9012A, B	--
Cyanide (Total)	Water		EPA 335.4	EPA 9012A, B	SM 4500-CN E 335.2-CLP-M (Ohio VAP)
	Waste		--	EPA 9012A, B	--
	Solid		--	EPA 9012A, B	335.2-CLP-M (Ohio VAP)
Cyanide (Weak and Dissociable) (Free)	Water			--	SM 4500-CN I
Dissolved Oxygen	Water		360.12	--	SM 4500 O-G
Flash Point	Waste		--	EPA 1010, 1010A	
	Solid		--	EPA 1010, 1010A	
Fluoride	Water		EPA 340.22		SM 4500 F-C, ISE
	Waste		EPA 340.2 (M) 2		--
	Solid				--
Iron, Ferrous & Ferric	Water			--	SM 3500 FE D
Hardness	Water		EPA 130.22	--	SM 2340B SM 2340C
Moisture	Solid		---	EPA 160.3 (M)	---
Nitrogen, Ammonia	Water		EPA 350.3 EPA 350.22	--	SM 4500 NH3-C(Titration) SM 4500 NH3-D(ISE)
	Waste		EPA 350.3 EPA 350.22	--	
	Solid		EPA 350.3 EPA 350.22	--	

Analytical Parameters	Matrix	Fields of Testing			
			CWA	RCRA (SW846)	Other
Total Kjeldahl Nitrogen (TKN)	Water		EPA 351.3	--	SM 4500 NH3-C
	Waste		EPA 351.3	--	--
	Solid		EPA 351.3	--	--
Oil and Grease (Hexane Extractable Material)	Water		EPA 1664A		--
	Waste		EPA 1664A		--
	Solid		--		--
Ortho-phosphate o-PO4	Water		EPA 365.1		SM 4500 P-E
	Waste				--
	Solid				--
pH	Water		EPA 150.12	EPA 9040B EPA 9040C	SM 4500 H+-B
	Waste			EPA 9045C, D EPA 9041	SM 4500 H+-B
	Solid		---	EPA 9045C, D	--
Paint Filter	Water		--	EPA 9095A	--
Phenolics	Water		EPA 420.1	--	--
	Waste		--	EPA 9065	--
	Solid		--	EPA 9065	--
Phosphorus (Total)	Water		EPA 365.1	--	SM 4500 P-E
	Waste		EPA 365.1	--	--
	Solid		EPA 365.1	--	--
Sulfate (SO4)	Water		EPA 375.42	EPA 9038	--
	Waste		EPA 375.42	EPA 9038	--
	Solid				--

Analytical Parameters	Matrix	Fields of Testing			
			CWA	RCRA	Other
Sulfide	Water		EPA 376.12	9030B/9034	SM 4500 S2-E
Total Organic Carbon (TOC) Total Petroleum Hydrocarbons	Water		EPA 415.12	EPA 9060	SM 5310 C
	Waste		--	EPA 9060	--
	Solid Water				Walkley-Black --
	Waste		EPA 1664A (SGT-HEM)		--
	Solid		--		--
Total Solids	Water		EPA 160.3	--	--
	Waste		EPA 160.3	--	--
	Solid		EPA 160.3 (M)	--	--
Total Dissolved Solids	Water		EPA 160.1	--	SM2540C
Total Suspended Solids	Water		EPA 160.2	---	SM2540D
Settleable Solids	Water		EPA 160.5	--	SM2540F
Turbidity	Water		EPA 180.1	--	--
Specific Gravity	Water				SM 2710F

Methods for Mercury by Cold Vapor Atomic Absorption

Analytical Parameters	**Matrix**		**Fields of Testing**		
			CWA	**RCRA (SW846)**	**Other**
Mercury (CVAA)	Water		EPA 245.1	EPA 7470A	--
	TCLP Leachate		--	EPA 7470A	--
	Waste		--	EPA 7471A, 7471B	--
	Solid			EPA 7471A, 7471B	--

Methods for Mercury by Cold Vapor Atomic Fluororescence

Analytical Parameters	**Matrix**		**Fields of Testing**		
			CWA	**RCRA (SW846)**	**Other**
Mercury, Low Level (CVAFS)	Water		--	--	EPA 1631E
	Solid		--	--	EPA 1631E

Methods for Metals by ICP and ICPMS

Analytical Parameters	Matrix		Fields of Testing		
			CWA	RCRA (SW846)	Other
Metals by ICP analysis	Water		EPA 200.7	EPA 6010B, 6010C	---
	Waste		---	EPA 6010B, 6010C	---
	Solid		EPA 200.7	EPA 6010B, 6010C	---
Metals by ICPMS analysis	Water		EPA 200.8	EPA 6020, 6020A	---
	Waste		---	EPA 6020, 6020A	---

Analytical Parameters	Matrix		Fields of Testing		
			CWA	RCRA (SW846)	Other
	Solid		EPA 200.8	EPA 6020, 6020A	---

Metals Sample Preparation Methods

Analytical Parameters	Matrix		Fields of Testing		
			CWA	RCRA (SW846)	Other
Toxicity Characteristic Leaching Procedure (TCLP)/ SPLP Extraction	Water		---	EPA 1311 EPA 1312	---
	Waste		---	EPA 1311 EPA 1312	---
	Solid		---	EPA 1311 EPA 1312	---
ICP Metals	Water		EPA 200.7	EPA 3005A EPA 3010A	---
	TCLP Leachate		---	EPA 3010A	---
	Waste		---	EPA 3050B	---
	Solid		---	EPA 3050B	---
ICPMS Metals	Water		EPA 200.8	EPA 3010A	---
	TCLP		---	EPA 3010A	---
	Waste		---	EPA 3050B	---
	Solid		---	EPA 3050B	---
CVAA Mercury	Water		EPA 245.1	EPA 7470A	---
	TCLP Leachate		---	EPA 7470A	---
	Waste		---	EPA 7471A EPA 7471B	---
	Solid		---	EPA 7471A EPA 7471B	
CVAFS Mercury Low Level	Water		---	---	EPA 1631E
	Solid		---	---	EPA 1631E

Organic Sample Preparation Methods

Analytical Parameters	Matrix	Fields of Testing			
			CWA	RCRA (SW846)	Other
Volatiles by GC/MS	Water		EPA 624	EPA 5030B EPA 5030C	---
	Waste		---	EPA 5030B EPA 5030C EPA 5035	---
	Solid		---	EPA 5035 EPA 5035A	---
Semivolatiles by GC/MS	Water		EPA 625	EPA 3510C EPA 3520C	---
	TCLP Leachate		---	EPA 3510C EPA 3520C	---
	Waste		---	EPA 3550B EPA 3550C EPA 3540C EPA 3580A	---
	Solid		---	EPA 3550B EPA 3550C EPA 3540C	---
Pesticides/PCBs by GC	Water		EPA 608	EPA 3510C EPA 3520C	---
	TCLP Leachate		---	EPA 3510C EPA 3520C	---
	Waste		---	EPA 3550B EPA 3550C EPA 3540C EPA 3546 (PCB only) EPA 3580A	---
	Solid		---	EPA 3550B EPA 3550C EPA 3540C	---

Analytical Parameters	Matrix	Fields of Testing			
			CWA	RCRA (SW846)	Other
Herbicides by GC	Water			EPA 8151A	---
	Waste		---	EPA 8151A	---
	Solid		---	EPA 8151A	---
Total Petroleum Hydrocarbons (Gasoline Range) by GC	Water		---	EPA 5030B EPA 5030C	WI GRO
	Waste		---	EPA 5030B EPA 5030C EPA 5035 EPA 5035A	WI GRO
	Solid		---	EPA 5035 EPA 5035A	WI GRO
Total Petroleum Hydrocarbons (Diesel Range) by GC	Water		---	EPA 3510C EPA 3520C	WI DRO
	TCLP Leachate		---	EPA 3510C EPA 3520C	---
	Waste		---	EPA 3550B EPA 3550C EPA 3580A	WI DRO
	Solid		---	EPA 3550B EPA 3550C	WI DRO

Organic Methods of Analysis

Analytical Parameters	Matrix	Fields of Testing			
			CWA	RCRA (SW846)	Other
Volatiles by GC/MS	Water		EPA 624	EPA 8260B EPA 8260C	---
	Waste		---	EPA 8260B EPA 8260C	---
	Solid		---	EPA 8260B EPA 8260C	---
Semivolatiles by GC/MS	Water		EPA 625	EPA 8270C EPA 8270D	
	Waste		---	EPA 8270C EPA 8270D	---
	Solid		---	EPA 8270C EPA 8270D	---
Pesticides/PCBs by GC	Water		EPA 608	Pesticides 8081A, 8081B PCBs 8082, 8082A	---
	TCLP Leachate		---	Pesticides 8081A, 8081B PCBs 8082, 8082A	---
	Waste		---	Pesticides 8081A, 8081B PCBs 8082, 8082A	---
	Solid		---	Pesticides 8081A, 8081B PCBs 8082, 8082A	---

Analytical Parameters	Matrix	Fields of Testing			
			CWA	RCRA (SW846)	Other
Phenoxyacid Herbicides by GC	Water		---	EPA 8151A	---
	TCLP Leachate		---	EPA 8151A	---
	Waste		---	EPA 8151A	---
	Solid		---	EPA 8151A	---
Gasoline Range Organics by GC	Water		---	EPA 8015B (M) EPA 8015C, D	WI GRO
	Waste		---	EPA 8015B (M) EPA 8015C, D	---
	Solid		---	EPA 8015B (M) EPA 8015C, D	WI GRO
Total Petroleum Hydrocarbons (Diesel Range) by GC/FID	Water		---	EPA 8015B (M) EPA 8015C, D	WI DRO
	Waste		---	EPA 8015B (M) EPA 8015C, D	---
Dissolved Gases RSK-175	Water		---	---	SOP
Formaldehyde Carbonyl Compounds	Water		---	EPA 8315A	---
	Solid		---	EPA 8315A	---
Aromatic Acids	Water		---	---	SOP
	Solid		---	---	SOP
Methyl Mercury	Water		EPA 1630	---	---
	Solid		EPA 1630	---	---

Appendix 3. Glossary/Acronyms

Glossary

Acceptance Criteria: Specified limits placed on characteristics of an item, process, or service defined in requirement documents. (ASQ)

Accreditation: The process by which an agency or organization evaluates and recognizes a laboratory as meeting certain predetermined qualifications or standards, thereby accrediting the laboratory.

Accuracy: The degree of agreement between an observed value and an accepted reference value. Accuracy includes a combination of random error (precision) and systematic error (bias) components which are due to sampling and analytical operations; a data quality indicator. (QAMS)

Analyst: The designated individual who performs the "hands-on" analytical methods and associated techniques and who is the one responsible for applying required laboratory practices and other pertinent quality controls to meet the required level of quality.

Analytical Uncertainty: A subset of Measurement Uncertainty that includes all laboratory activities performed as part of the analysis. (TNI)

Assessment: The evaluation process used to measure or establish the performance, effectiveness, and conformance of an organization and/or its systems to defined criteria (to the standards and requirements of laboratory accreditation). (TNI)

Audit: A systematic and independent examination of facilities, equipment, personnel, training, procedures, record-keeping, data validation, data management, and reporting aspects of a system to determine whether QA/QC and technical activities are being conducted as planned and whether these activities will effectively achieve quality objectives. (TNI)

Batch: Environmental samples which are prepared and/or analyzed together with the same process and personnel, using the same lot(s) of reagents. A preparation batch is composed of one to 20 environmental samples of the same matrix, meeting the above mentioned criteria and with a maximum time between the start of processing of the first and last sample in the batch to be 24 hours. An analytical batch is composed of prepared environmental samples (extracts, digestates or concentrates) which are analyzed together as a group. An analytical batch can include prepared samples originating from various quality system matrices and can exceed 20 samples. (TNI)

Bias: The systematic or persistent distortion of a measurement process, which causes errors in one direction (i.e., the expected sample measurement is different from the sample's true value). (TNI)

Blank: A sample that has not been exposed to the analyzed sample stream in order to monitor contamination during sampling, transport, storage or analysis. The blank is subjected to the usual analytical and measurement process to establish a zero baseline or background value and is sometimes used to adjust or correct routine analytical results. (ASQ)

Calibration: A set of operations that establish, under specified conditions, the relationship between values of quantities indicated by a measuring instrument or measuring system, or values represented by a material measure or a reference material, and the corresponding values realized by standards. (TNI)

1) In calibration of support equipment the values realized by standards are established through the use of reference standards that are traceable to the International System of Units (SI).

2) In calibration according to methods, the values realized by standards are typically established through the use of Reference Materials that are either purchased by the laboratory with a certificate of analysis or purity, or prepared by the laboratory using support equipment that has been calibrated or verified to meet specifications.

Calibration Curve: The mathematical relationship between the known values, such as concentrations, of a series of calibration standards and their instrument response. (TNI)

Calibration Standard: A substance or reference material used to calibrate an instrument (QAMS)

Certified Reference Material (CRM): A reference material accompanied by a certificate having a value, measurement uncertainty, and stated metrological traceability chain to a national metrology institute.

Chain-of-Custody: Record that documents the possession of the samples from the time of collection to receipt in the laboratory. This record generally includes the number and types of containers, the mode of collection, the collector, time of collection, preservation, and requested analyses. (TNI)

Compromised Samples: Those samples which are improperly sampled, insufficiently documented (chain of custody and other sample records and/or labels), improperly preserved, collected in improper containers, or exceeding holding times when delivered to a laboratory. Under normal conditions, compromised samples are not analyzed. If emergency situation require analysis, the results must be appropriately qualified.

Confidential Business Information (CBI): Information that an organization designates as having the potential of providing a competitor with inappropriate insight into its management, operation or products. TNI and its representatives agree to safeguarding identified CBI and to maintain all information identified as such in full confidentiality.

Confirmation: Verification of the identity of a component through the use of an approach with a different scientific principle from the original method. These may include, but are not limited to:

Second column confirmation

Alternate wavelength

Derivatization

Mass spectral interpretation

Alternative detectors or

Additional cleanup procedures

Conformance: An affirmative indication or judgment that a product or service has met the requirements of the relevant specifications, contract, or regulation; also the state of meeting the requirements. (ANSI/ASQC E4-1994)

Correction: Actions necessary to correct or repair analysis specific non-conformances. The acceptance criteria for method specific QC and protocols as well as the associated corrective actions. The analyst will most frequently be the one to identify the need for this action as a result of calibration checks and QC sample analysis. No significant action is taken to change behavior, process or procedure.

Corrective Action: The action taken to eliminate the causes of an existing nonconformity, defect or other undesirable situation in order to prevent recurrence. (ISO 8402)

Data Audit: A qualitative and quantitative evaluation of the documentation and procedures associated with environmental measurements to verify that the resulting data re of acceptable quality (i.e., that they meet specified acceptance criteria).

Data Reduction: The process of transforming the number of data items by arithmetic or statistical calculations, standard curves, and concentration factors and collation into a more useable form. (TNI)

Deficiency: An unauthorized deviation from acceptable procedures or practices, or a defect in an item. (ASQC)

Demonstration of Capability: A procedure to establish the ability of the analyst to generate analytical results of acceptable accuracy and precision. (TNI)

Document Control: The act of ensuring that documents (and revisions thereto) are proposed, reviewed for accuracy, approved for release by authorized personnel, distributed properly, and controlled to ensure use of the correct version at the location where the prescribed activity if performed. (ASQ)

Duplicate Analyses: The analyses or measurements of the variable of interest performed identically on two subsamples of the same sample. The results from duplicate analyses are used to evaluate analytical or measurement precision but not the precision of sampling, preservation or storage internal to the laboratory. (EPA-QAD)

Equipment Blank: Sample of analyte-free media which has been used to rinse common sampling equipment to check effectiveness of decontamination procedures.

External Standard Calibration: Calibrations for methods that do not utilize internal standards to compensate for changes in instrument conditions.

Field Blank: Blank prepared in the field by filing a clean container with pure de-ionized water and appropriate preservative, if any, for the specific sampling activity being undertaken (EPA OSWER)

Field of Accreditation: Those matrix, technology/method, and analyte combinations for which the accreditation body offers accreditation.

Holding Times: The maximum time that samples may be held prior to analyses and still be considered valid or not compromised. (40 CFR Part 136)

Internal Standard: A known amount of standard added to a test portion of a sample as a reference for evaluating and controlling the precision and bias of the applied analytical test method. (TNI)

Internal Standard Calibration: Calibrations for methods that utilize internal standards to compensate for changes in instrument conditions.

Instrument Blank: A clean sample (e.g., distilled water) processed through the instrumental steps of the measurement process; used to determine instrument contamination. (EPA-QAD)

Instrument Detection Limit (IDL): The minimum amount of a substance that can be measured with a specified degree of confidence that the amount is greater than zero using a specific instrument. The IDL is associated with the instrumental portion of a specific method only, and sample preparation steps are not considered in its derivation. The IDL is a statistical estimation at a specified confidence interval of the concentration at which the relative uncertainty is + 100%. The IDL represents a range where qualitative detection occurs on a specific instrument. Quantitative results are not produced in this range.

Laboratory Control Sample (however named, such as laboratory fortified blank, spiked blank, or QC check sample): A sample matrix, free from the analytes of interest, spiked with verified known amounts of analytes or a material containing known and verified amounts of analytes, taken through all preparation and analysis steps of the procedure unless otherwise noted in a reference method. It is generally used to establish intra-laboratory or analyst specific precision and bias or to assess the performance of all or a portion of the measurement system. An LCS must be prepared at a minimum of 1 per batch of 20 or less samples per matrix type per sample extraction or preparation method except for analytes for which spiking solutions are not available such as total suspended solids, total dissolved solids, total volatile solids, total solids, pH, color, odor, temperature, dissolved oxygen or turbidity. The results of these samples must be used to determine batch acceptance.

Least Squares Regression (1st Order Curve): The least squares regression is a mathematical calculation of a straight line over two axes. The y axis represents the instrument response (or Response ratio) of a standard or sample and the x axis represents the concentration. The regression calculation will generate a correlation coefficient (r) that is a measure of the "goodness of fit" of the regression line to the data. A value of 1.00 indicates a perfect fit. In order to be used for quantitative purposes, r must be greater than or equal to 0.99 for organics and 0.995 for inorganics.

Limit(s) of Detection (LOD) (a.k.a., Method Detection Limit [MDL]): A laboratory's estimate of the minimum amount of an analyte in a given matrix that an analytical process can reliabl detect in their facility. (TNI)

LOD Verification (a.k.a., MDL Verification): A processed QC sample in the matrix of interest, spiked with the analyte at no more than 3X the LOD for single analyte tests and 4X the LOD for multiple analyte tests and processed through the entire analytical procedure.

Limit(s) of Quantitation (LOQ) [a.k.a., Reporting Limit]: The minimum levels, concentrations, or quantities of a target variable (e.g., target analyte) that can be reported with a specified degree of confidence. (TNI)

(QS) Matrix: The component or substrate that contains the analyte of interest. For purposes of batch and QC requirement determinations, the following matrix distinctions must be used:

Aqueous: Any aqueous sample excluded from the definition of Drinking Water matrix or Saline/Estuarine source. Includes surface water, groundwater, effluents, and TCLP or other extracts.

Drinking Water: any aqueous sample that has been designated as a potable or potential potable water source.

Saline/Estuarine: any aqueous sample from an ocean or estuary, or other salt water source such as the Great Salt Lake.

Non-aqueous Liquid: any organic liquid with ,15% settleable solids.

Biological Tissue: any sample of a biological origin such as fish tissue, shellfish, or plant material. Such samples must be grouped according to origin.

Solids: includes soils, sediments, sludges, and other matrices with .15% settleable solids.

Chemical Waste: a product or by-product of an industrial process that results in a matrix not previously defined.

Air and Emissions: whole gas or vapor samples including those contained in flexible or rigid wall containers and the extracted concentrated analytes of interest from a gas or vapor that are collected with a sorbant tube, impinger solution, filter, or other device. (TNI)

Matrix Spike (spiked sample or fortified sample): A sample prepared, taken through all sample preparation and analytical steps of the procedure unless otherwise noted in a referenced method, by adding a known amount of target analyte to a specified amount of sample for which an independent test result of target analyte concentration is available. Matrix spikes are used, for example, to determine the effect of the matrix on a method's recovery efficiency.

Matrix Spike Duplicate (spiked sample or fortified sample duplicate): A replicate matrix spike is prepared and analyzed to obtain a measure of the precision of the recovery for each analyte.

Method Blank: A sample of a matrix similar to the batch of associated samples (when available) that is free from the analytes of interest and is processed simultaneously with and under the same conditions as samples through all steps of the analytical procedures, and in which no target analytes or interferences are present at concentrations that impact the analytical results for sample analyses.

Method Detection Limit: The minimum concentration of a substance (an analyte) that can be measured and reported with 99% confidence that the analyte concentration is greater than zero

and is determined from analysis of a sample in a given matrix containing the analyte. (40 CFR Part 136, Appendix B)

Negative Control: Measures taken to ensure that a test, its components, or the environment do not cause undesired effects, or produce incorrect test results.

Non-conformance: An indication, judgment, or state of not having met the requirements of the relevant specifications, contract, or regulation.

Performance Audit: The routine comparison of independently obtained qualitative and quantitative measurement system data with routinely obtained data in order to evaluate the proficiency of an analyst or laboratory.

Positive Control: Measures taken to ensure that a test and/or its components are working properly and producing correct or expected results from positive test subjects.

Precision: The degree to which a set of observations or measurements of the same property, obtained under similar conditions, conform to themselves; a data quality indicator. Precision is usually expressed as standard deviation, variance or range, in either absolute or relative terms. (TNI)

Preservation: Any conditions under which a sample must be kept in order to maintain chemical and/or biological integrity prior to analysis. (TNI)

Proficiency Testing: A means of evaluating a laboratory's performance under controlled conditions relative to a given set of criteria through analysis of unknown samples provided by an external source. (TNI)

Proficiency Testing Program: The aggregate of providing rigorously controlled and standardized environmental samples to a laboratory for analysis, reporting of results, statistical evaluation of the results and the collective demographics and results summary of all participating laboratories. (TNI)

Proficiency Test Sample (PT): A sample, the composition of which is unknown to the laboratory and is provided to test whether the laboratory can produce analytical results within specified acceptance criteria. (TNI)

Quality Assurance: An integrated system of management activities involving planning, implementation, assessment, reporting and quality improvement to ensure that a process, item, or service is of the type of quality needed and expected by the client. (TNI)

Quality Assurance [Project] Plan (QAPP): A formal document describing the detailed quality control procedures by which the quality requirements defined for the data and decisions pertaining to a specific project are to be achieved. (EAP-QAD)

Quality Control: The overall system of technical activities that measures the attributes and performance of a process, item, or service against defined standards to verify that they meet the stated requirements established by the customer; operational techniques and activities that are used to fulfill requirements for quality; also the system of activities and checks used to ensure that measurement systems are maintained within prescribed limits, providing protection against "out of control" conditions and ensuring that the results are of acceptable quality. (TNI)

Quality Control Sample: A sample used to assess the performance of all or a portion of the measurement system. One of any number of samples, such as Certified Reference Materials, a quality system matrix fortified by spiking, or actual samples fortified by spiking, intended to demonstrate that a measurement system or activity is in control. (TNI)

Quality Manual: A document stating the management policies, objectives, principles, organizational structure and authority, responsibilities, accountability, and implementation of an agency, organization, or laboratory, to ensure the quality of its product and the utility of its product to its users. (TNI)

Quality System: A structured and documented management system describing the policies, objectives, principles, organizational authority, responsibilities, accountability, and implementation plan of an organization for ensuring quality in its work processes, products (items), and services. The quality system provides the framework for planning, implementing, and assessing work performed by the organization and for carrying out required QA and QC activities. (TNI)

Raw Data: The documentation generated during sampling and analysis. This documentation includes, but is not limited to, field notes, electronic data, magnetic tapes, untabulated sample results, QC sample results, print outs of chromatograms, instrument outputs, and handwritten records. (TNI)

Record Retention: The systematic collection, indexing and storing of documented information under secure conditions.

Reference Material: A material or substance one or more properties of which are sufficiently well established to be used for the calibration of an apparatus, the assessment of a measurement method, or for assigning values to materials. (ISO Guide 30-2.1)

Reference Method: A method of known and documented accuracy and precision issued by an organization recognized as competent to do so. (NELAC)

Reference Standard: A standard, generally of the highest metrological quality available at a given location, from which measurements made at that location are derived. (VIM-6.0-8)

Sampling: Activity related to obtaining a representative sample of the object of conformity assessment, according to a procedure.

Second Order Polynomial Curve (Quadratic): The 2nd order curves are a mathematical calculation of a slightly curved line over two axis. The y axis represents the instrument response (or Response ratio) of a standard or sample and the x axis represents the concentration. The 2nd order regression will generate a coefficient of determination (COD or r2) that is a measure of the "goodness of fit" of the quadratic curvature the data. A value of 1.00 indicates a perfect fit. In order to be used for quantitative purposes, r2 must be greater than or equal to 0.99.

Selectivity: The ability to analyze, distinguish, and determine a specific analyte or parameter from another component that may be a potential interferent or that may behave similarly to the target analyte or parameter within the measurement system. (TNI)

Sensitivity: The capability of a method or instrument to discriminate between measurement responses representing different levels (e.g., concentrations) of a variable of interest. (NELAC)

Spike: A known mass of target analyte added to a blank, sample or sub-sample; used to determine recovery efficiency or for other quality control purposes.

Standard: The document describing the elements of laboratory accreditation that has been developed and established within the consensus principles of standard setting and meets the approval requirements of standard adoption organizations procedures and policies. (TNI)

Standard Operating Procedures (SOPs): A written document which details the method of an operation, analysis, or action with thoroughly prescribed techniques and steps. SOPS are officially approved as the methods for performing certain routine or repetitive tasks. (TNI)

Storage Blank: A blank matrix stored with field samples of a similar matrix (volatiles only) that measures storage contribution to any source of contamination.

Surrogate: A substance with properties that mimic the analyte of interest. It is unlikely to be found in environment samples and is added to them for quality control purposes. Surrogate compounds must be added to all samples, standards, and blanks, for all organic chromatography methods except when the matrix precludes its use or when a surrogate is not available. Poor surrogate recovery may indicate a problem with sample composition and must be reported to the client whose sample produced poor recovery. (QAMS)

Systems Audit (also Technical Systems Audit): A thorough, systematic, qualitative on-site assessment of the facilities, equipment, personnel, training, procedures, record keeping, data validation, data management, and reporting aspects of a total measurement system. (EPA-QAD)

Technical Manager: A member of the staff of an environmental laboratory who exercises actual day-to-day supervision of laboratory operations for the appropriate fields of accreditation and reporting of results

Technology: A specific arrangement of analytical instruments, detection systems, and/or preparation techniques.

Traceability: The ability to trace the history, application, or location of an entity by means of recorded identifications. In a calibration sense, traceability relates measuring equipment to national or international standards, primary standards, basic physical constants or properties, or reference materials. In a data collection sense, it relates calculations and data generated throughout the project back to the requirements for the quality of the project. (TNI)

Trip Blank: A blank matrix placed in a sealed container at the laboratory that is shipped, held unopened in the field, and returned to the laboratory in the shipping container with the field samples.

Uncertainty: A parameter associated with the result of a measurement that characterizes the dispersion of the value that could reasonably be attributed to the measured value.

Acronyms

ASTM	American Society for Testing & Materials
CAR	Corrective Action Report
CBI	Confidential Business Information
CCB	Continuing Calibration Blank
CCV	Continuing Calibration Verification
CF	Calibration Factor
CFR	Code of Federal Regulations
COC	Chain of Custody
CQMP	Corporate Quality Management Plan
CSM	Customer Service Manager
DOC	Demonstration of Capability
DoD	Department of Defense
DQO	Data Quality Objectives
DUP	Duplicate
ECO	Ethics and Compliance Officer
EDD	Electronic Data Deliverable
EHS	Environment, Health and Safety
EPA	Environmental Protection Agency
GC	Gas Chromatography
GC/MS	Gas Chromatography/Mass Spectrometry
HPLC	High Performance Liquid Chromatography
ICP	Inductively Coupled Plasma Atomic Emission Spectroscopy
ICP/MS	ICP/Mass Spectrometry
ICB	Initial Calibration Blank
ICV	Initial Calibration Verification
IDL	Instrument Detection Limit
IEC	International Electrotechnical Commission
IS	Internal Standard
ISO	International Organization for Standardization
LCS	Laboratory Control Sample
LCSD	Laboratory Control Sample Duplicate
LOD	Limit of Detection
LOQ	Limit of Quantitation
LIMS	Laboratory Information Management System
MDL	Method Detection Limit
MDLCK	MDL Check Standard
MDLV	MDL Verification Check Standard
MRL	Method Reporting Limit Check Standard
MS	Matrix Spike
MSD	Matrix Spike Duplicate
MSDS	Material Safety Data Sheet
NCM	Nonconformance Memo
NELAP	National Environmental Laboratory Accreditation Program
NIST	National Institute of Standards and Technology
NPDES	National Pollutant Discharge Elimination System
OVAP	Ohio Voluntary Action Program
PM	Project Manager
PT	Performance Testing
TIC	Tentatively Identified Compound
TNI	The NELAC Institute

QAM	Quality Assurance Manual
QA/QC	Quality Assurance / Quality Control
QAPP	Quality Assurance Project Plan
RCRA	Resource Conservation and Recovery Act
RF	Response Factor
RFP	Request for Proposal
RPD	Relative Percent Difference
RSD	Relative Standard Deviation
SAP	Sampling and Analysis Plan
SD	Standard Deviation
SOP	Standard Operating Procedure
SPLP	SPLP = Synthetic Precipitation Leaching Procedure
TAT	Turn-Around Time
TCLP	Toxicity Characteristic Leaching Procedure
TSCA	Toxic Substances Control Act
USACE	United States Army Corps of Engineers
USDA	United States Department of Agriculture
VOA	Volatiles

Appendix 4. Laboratory Certifications, Accreditations, Validations

TestAmerica North Canton maintains certifications, accreditations, certifications, and approvals with numerous state and national entities. Programs vary but may include on-site audits, reciprocal agreements with another entity, performance testing evaluations, review of the QA Manual, Standard Operating Procedures, Method Detection Limits, training records, etc. At the time of this QA Manual revision, the laboratory has accreditation/certification/licensing with the following organizations:

Organization	Certificate Number	Organization	Certificate Number
California	01144CA	Nevada	OH-00048208A
Connecticut	PH-0590	New Jersey	OH001
Florida	E87225	New York	10975
Georgia	---	OVAP	CL0024
Illinois	001298	Pennsylvania	68-00340
Kansas	E-10336	USDA (Dept. of Agriculture)	P330-08-00123
Kentucky Underground Storage Tank Program	0058	Washington	C971
Minnesota	039-999-348	West Virginia	210
DoD – LAB	L2315	Wisconsin	999518190
Texas	T104704517-13-2	Virginia	2857

The certificates and accredited parameter lists are available for each State/Program at www.testamericainc.com under Analytical Services Search – Certifications.

Appendix D

Pace Analytical Energy Services, LLC.
220 William Pitt Way
Pittsburgh, PA 15238
412-826-5245

QUALITY SYSTEMS MANUAL

Controlled Copy No. _____

Signatures of Final Approval:

_____ 11/19/15
Aaron Peacock — Date
General Manager

Charlotte Washlaski 11/19/15
Charlotte Washlaski — Effective Date
Quality Manager

Organizational Units

Natural Attenuation

Petroleum Forensics

Molecular Diagnostics

CSIA

Review Date: October 27, 2015

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Review Date: November 16, 2015

1.0 Introduction, Purpose, and Scope

1.1 Introduction

Pace Analytical Energy Services (PAES) recognizes its crucial role in providing reliability and excellence in the environmental analytical industry. The laboratory provides information necessary for engineering, industrial, and regulatory clients to make informed judgments and applicable policy decisions. PAES' management acknowledges that uncompromising dedication to quality is fundamental to remaining a competitive force in the analytical services market.

1.2 Purpose

The purpose of this Quality Systems Manual is to outline a program of policies, procedures, and documentation, which assures that our analytical services meet a defined standard of quality on an ongoing basis. This document defines the standards under which all laboratory operations will be performed. As supplemented by Standard Operating Procedures (SOPs), the Quality Systems Manual describes the laboratory's organization, objectives, and operating philosophy.

PAES Quality Systems Manual contains references to the laboratory's policies and operational procedures that have been established in order to meet the quality requirements of the TNI Standards and the following Quality Policy Statement.

The laboratory shall continually improve the effectiveness of its management system through the use of the quality policy, quality objectives, audit results, analysis of data, corrective and preventive actions and management review.

1.2.1 PAES' Quality Policy Statement

PAES is an organization that provides information and environmental services to a very diverse client base. In all processes from initial customer contact to project completion, PAES aim is to offer clients a reliable product of the best quality that is delivered in a timely manner at a reasonable price. This Policy Statement represents a top level management commitment and shall be achieved using the following goals:

1. Production of accurate information.
2. Adherence to an ethical standard that demands continuous honesty and integrity.
3. Achievement of customer satisfaction.
4. Establishment of a documented trail to support the results.
5. Maintenance of a pleasant working environment where employees are treated equitably and fairly.

These goals are fundamental to all of PAES' actions.

The Standard Operating Procedures and PAES Quality Systems Manual detail the procedures for achieving these goals. Management personnel are charged with ensuring all applicable procedures are completed in the spirit of the Quality Policy. They are available to all employees to assist in applying these principles and to advise appropriate action. It is the responsibility of each PAES employee to consistently act as directed by the five goals of quality. Further, it is their responsibility to consult their immediate superior for direction if an issue arises for which the response is unclear.

If PAES' Management realizes that these goals are not achievable but the validity and appropriateness of client results is not jeopardized, we will inform affected clients of the situation and allow them to alter their employ of PAES' services accordingly. If the client's data are to be negatively impacted where the validity of the results is in question, or a clients' project is operationally or legally jeopardized, the following procedures shall be followed:

1. Concerned operations will be suspended.

2. Affected clients will be notified.

3. Alternative procedures for securing the requested services will be employed until the corrective actions are completed to a level that is consistent with PAES' documented procedures and is satisfactory to management.

To achieve these quality goals, all laboratory data must be properly documented, legally defensible, and supported by statistically defined and verifiable confidence limits. Falsification of data under any circumstance is unacceptable and is grounds for termination. PAES follows the Pace Analytical Employee Handbook which provides policies and procedures to help employees avoid involvement in any activities that would diminish confidence in PAES competence, impartiality, judgment and/or operational integrity.

PAES uses EPA-approved methodologies such as those found in Standard Methods and SW-846, whenever methods are available. If an EPA-approved method has not been specified, PAES will select an industry recognized and validated method for use or will develop an internal method based upon thorough research and good scientific methods. In all instances of scientific innovation, PAES recognizes the value of a firm commitment to quality and integrity.

1.3 Scope of Quality Systems Manual

This document serves as both the PAES, Inc. Quality Systems Manual and the PAES Laboratory Quality Assurance Plan. It contains both quality assurance policies and quality control procedures that are followed to ensure and document the quality of analytical data. This manual provides detail concerning quality management requirements employed at PAES for the documented acquisition of samples, analysis of those samples via specific tests, the reporting of that data to the client, and the ultimate disposal of samples.

1.4 Scope of Services

PAES offers a comprehensive scope of laboratory analytical services to environmental consultants, industries, governmental agencies, and municipalities. The scope of services include:

Wastewater and storm water

- Ion analysis via Ion Chromatography
- Wet Chemistry analyses for pH and TOC/DOC

In Situ Remediation Analyses

- Dissolved Gas (Oxygen, Nitrogen, Carbon Dioxide, Methane, Ethane and Ethene)
- Volatile Fatty Acids (Lactic, Pyruvic, Formic, Acetic Propanoic, Butyric Acids)
- Ion Chromotography Analyses of sulfate, ferric iron, ferrous iron and divalent manganese
- Compound Specific Isotope Analysis (CSIA) of VOCs in groundwater and vapor

Soil Vapor Extraction Analyses

- VOC's in vapor
- nitrogen, oxygen, carbon dioxide and methane in vapor

Shale Gas Analyses

- Compositional Analysis (nitrogen, oxygen, argon, carbon dioxide, C1-C6)
- Carbon isotopic ratio ($^{13}C/^{12}C$ or $\delta^{13}C$) of methane, ethane
- Hydrogen isotopic ratio ($^{2}H/^{1}H$ or $\delta^{2}H$) of methane

Petroleum Forensics

- C3-C10 Gasoline Range Hydrocarbons
- Oxygenates in product
- GC/MS Full Scan analyses
- Extended PAH analyses
- Whole oil analyses
- Boiling Range Distribution of Petroleum Fractions
- EDB and Organic Lead

Molecular Diagnostics

- MicroArray
- qPCR
- DNA extraction

Training Seminars

1.5 Certifications

PAES holds the following certifications:

- National Environmental Laboratory Accreditation Program (NELAP): Pennsylvania
- Connecticut
- Virginia
- South Carolina
- Texas
- New York
- New Jersey
- New Hampshire
- West Virginia

Specific parameter lists for the various certifications are available from the Customer Service Department upon request.

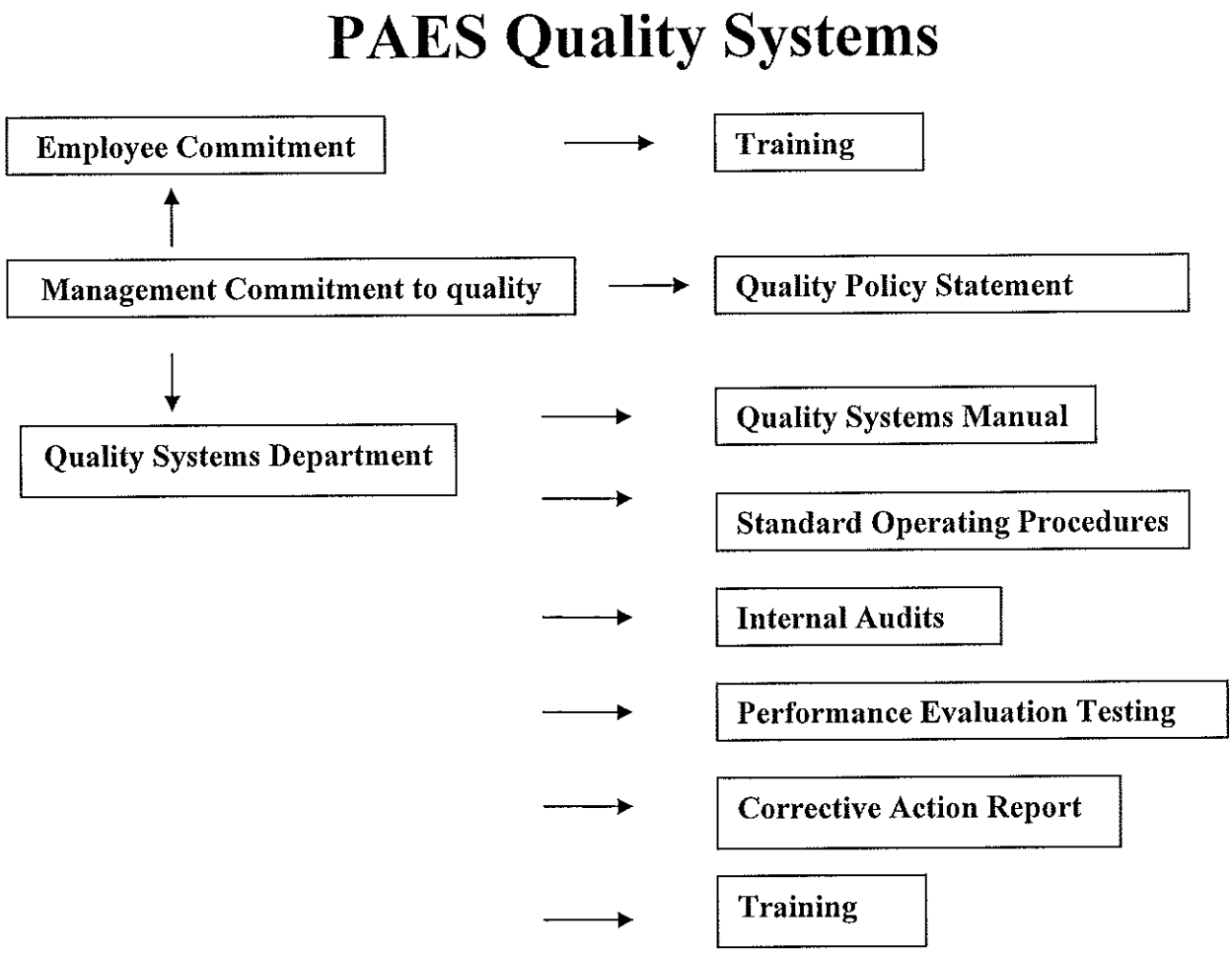
Review Date: October 27, 2015

2.0 Quality Systems – Establishment and Audits

2.1 Establishment of a Quality System

Pace Analytical Energy Services (PAES) has established a quality system based upon the fundamentals of good laboratory practices and the requirements outlined in the TNI Standard of the National Environmental Laboratory Accreditation Program. Although PAES provides a variety of environmental services, PAES' Quality System has been designed according to the type, range, and volume of analytical testing activities undertaken in the laboratories. This section describes PAES' Quality System and outlines the policy and procedures for implementing corrective action when non-conforming work or departures from policies and procedures occur.

2.2 Elements of PAES Quality System



This flowchart shows the general elements of PAES Quality Systems. Each area of this flowchart is addressed or referenced in this Quality Systems Manual.

2.2.1 Quality Manual Review

The PAES Quality Systems Manual is reviewed annually for accuracy and applicability. These records are maintained in the Quality Systems Department Office. All revisions will be conducted in accordance with PAES Standard Operating Procedure for Document Control.

2.2.1.1 Document Control

Document control procedures are specified in PAES Standard Operating Procedure for Document Control. The Standard Operating Procedure outlines document control procedures for generating, formatting, revising, approving, tracking, distributing, indexing, archiving, and destroying controlled documents, including the Quality Systems Manual.

2.2.2 Internal Audits

Technical audits serve to verify compliance with method-specific procedures including operations related to test methods. Any audit that is conducted on an operation that is involved with data generation and the assurance of its quality is a technical audit. System audits function to verify compliance with the laboratory's quality system. Types of procedures that would be reviewed as a part of a systems audit could include: (1) response to complaints; (2) sample tracking methodologies; and (3) sample acceptance policies.

The Quality Systems Department will coordinate all technical and system audits. Audits shall be conducted by individuals who are independent of the activity to be audited. All internal auditors shall be trained and qualified in the areas in which they will be conducting the audit.

2.2.2.1 Audit Frequency

Internal Audits are scheduled and may be conducted by the Quality Systems Department or their designees, and may either be scheduled or unannounced. PAES conducts internal technical audits and internal system audits at least annually. The audits are conducted to insure that PAES' operations continue to comply with the Quality Systems requirements specified in the Quality Systems Manual and Standard Operating Procedures. The Quality Systems Department maintains an audit schedule to ensure that all fields of accreditation covered by the laboratory quality system are audited. Internal audits of its activities must verify that its operations continue to comply with the requirements of the management system.

2.2.2.2 Procedures for Internal Audits

Audits will be conducted on analytical groups or systems according to the annual audit schedule posted in the Quality Systems Department Office. Immediately prior to starting the audit

Operations will be notified. PAES' Standard Operating Procedure ADM-4 for Internal Laboratory Audits outlines the specific procedures for conducting an internal audit.

According to the SOP, the audit is performed using the appropriate audit check sheet as a guide. The audit check sheet will be selected and used as the auditing guide for the area that is to be audited. The audit check sheets delineate the activities and records that will be reviewed. The sheet is completed and additional notes are made by the auditor based upon observations, interviews, and record reviews.

2.2.2.3 Internal Audit Findings and Corrective Action

Using the audit check sheets and supplementary notes, an Internal Audit Report (Figure 2-1) is prepared by the Quality Systems Department. The Internal Audit Report contains an overall summary of the audit, including both items of a positive nature, as well as deficiencies. A follow-up evaluation section is also included. The cause of each deficiency is determined using Root Cause Analysis. Root Cause Analysis is the foundation upon which all Corrective Action is based. This process and an example are outlined in Figure 2-2 in this Quality Systems Manual.

Corrective Action based upon the root cause analysis is indicated on a Corrective Action Report (see Figure 2-3). A Corrective Action Report is prepared for each deficiency listed on the Internal Audit Report. The Internal Audit Report and Corrective Action Report are forwarded to the appropriate Department Head for corrective action. A follow-up audit is conducted and documented.

If the audit was of a technical nature, the Audit Report will be forwarded to the Laboratory Manager. The Laboratory Manager will meet with the specific Department Manager the first business day once the audit findings are received. The audit will be discussed along with the recommendations for corrective action. Corrective action is expected to take place immediately or as soon as possible following the audit. A follow-up audit of any deficient area(s) will be conducted within 60-120 days of audit completion, or as soon as corrective action is completed in order to monitor the effectiveness of corrective action. This timeframe is just a guide.

Where any audit findings or defective measuring or test equipment may cast doubt on the correctness or validity of the laboratory's calibrations or test results, PAES shall take corrective action as specified in PAES' Quality Policy Statement. If the subsequent investigation shows that laboratory results have been affected, the affected client shall be notified in writing by the Customer Service Office.

2.2.2.4 Work Stoppage

The Quality Systems Department has the authority to stop any work that is found to be unsatisfactory or to prevent reporting of unjustifiable results. The work will not be ordered to commence until corrective action is taken that insures satisfactory work and reliable results according to the Quality Systems Department's discretion.

2.2.3 Performance Evaluation Audits

Performance evaluation audits enable PAES to measure the precision, accuracy, and comparability of laboratory-generated data through the use of blind reference materials. PAES participates in performance evaluation studies required by the EPA and several state agencies. Performance evaluation studies are completed as required to maintain necessary certifications, and as required as an integral part of an internal audit at the Quality Systems Department's discretion.

Performance evaluation studies for all accredited parameters are planned for testing at least twice each year. The Quality Systems office maintains EXCEL spreadsheets of results so that trends are easily noticeable.

In situations where the analyst is to know that a performance evaluation is being conducted, the analyst prepares the samples according to the instructions provided. If the PE is to be a blind audit, the Quality Systems Department prepares the samples. The samples are analyzed as soon as possible after opening the vials to avoid sample deterioration. Prior to reporting the results to the appropriate agency, the General Manager/Assistant General Manager and the Quality Systems Manager evaluate results of the performance evaluation samples.

2.2.3.1 Performance Evaluation Findings and Corrective Action

Once the evaluation report from the Performance Evaluation Provider or appropriate agency is received, the Quality Manager forwards the findings to the Laboratory Manager/Assistant General Manager. Unacceptable results are investigated to determine the root cause of the failures. The following points are addressed during the investigation:

- Potential for reporting/calculation errors
- Preparation of calibration standards
- Evaluation of quality control data associated with the analysis
- Evaluation of analytical technique and instrument performance

Additional Performance Evaluation samples may be submitted for analysis if the Quality Systems Department determines it is necessary to ensure that an analytical method, technique, or instrument performance problem is corrected.

2.2.4 External Audits

External Audits are conducted as necessary to retain laboratory certifications or at a client's request. The Quality Systems Department is the liaison between PAES and an external auditor. The Quality Systems Department is responsible for notifying the laboratory staff of upcoming audits. This notification will include the agency that will perform the audit, the reason for the audit, the dates involved, and the areas of concern.

During the audit, laboratory personnel will be available to the auditor as requested, as will any documentation necessary for the auditor to obtain sufficient information to effectively evaluate the laboratory. If laboratory information of a proprietary nature is necessary to complete an audit, the auditor will be required to complete and sign PAES Confidentiality Agreement.

2.2.4.1 External Audit Findings and Corrective Action

The Quality Systems Department will prepare a report summarizing the findings of the post audit meeting. Following review of this report, any deficiencies noted by the auditor will be addressed immediately. Corrective action will be taken to eliminate the cause of a deficiency and to prevent recurrence. The Corrective Action process shall identify and implement corrective actions to eliminate the root cause of the deficiency. The development and implementation of a corrective action plan shall not be contingent upon the receipt of the external auditor's report.

When the External Audit Report is received at PAES, deficiencies will be addressed in the order of their priority as determined by the auditor. The Quality Systems Department will prepare a response plan for correcting the reported deficiencies and will submit a Corrective Action Plan to the auditing agency. Corrective action will be taken according to the timetable outlined by the plan.

2.2.5 Quality Systems Audit

Laboratory Management shall conduct a review of the Quality System and its testing and calibration activities. This review shall be conducted to ensure the Quality System's suitability and effectiveness and to introduce any necessary changes or improvements in the quality system and laboratory operations. This review shall be conducted annually by the GM/AGM and/or their designee's.

The review will be conducted in the same manner as an Internal Systems Audit, but the auditors will be made up of the GM/AGM and/or their designee's. PAES' Standard Operating Procedure ADM-4 includes an Audit Check Sheet for the Quality Systems Audit, which outlines the review procedure.

2.2.5.1 Quality Systems Audit Findings and Corrective Action

The review findings shall be documented on an Audit Report Form and submitted to the Quality Systems Department for review. Corrective Action Reports will be generated for the audit deficiencies and will be resolved as necessary. A timeline for resolution is specified on the Corrective Action Report and the review findings become an item for discussion by the GM/AGM and/or their designee's where they ensure the corrective actions are completed.

2.2.5.2 Quality Systems Report

Regular discussions of quality assurance issues are necessary to provide a forum in which upper management are informed of problems and changes that affect the laboratory operations. The Quality Systems Department regularly provides a report to the Assistant General Manager to

discuss quality issues. This report serves as a general review of factors affecting quality and will include the following topics at a minimum:

- Personnel changes
- Instrument changes
- Internal and External Audit findings
- Certification changes
- Testing and calibration activities
- Quality System implementation activities and progress

2.2.6 Review of Laboratory Management System

The laboratory must conduct a review of the management system. This review shall be conducted by top management. This should include the GM/AGM, the Quality Manager, and any others as determined by the GM/AGM. Reference SOP S-ALL-Q-015 for procedures.

2.3 Additional Quality Control Checks

In addition to periodic audits, PAES ensures the quality of results provided to clients by implementing additional checks to monitor the quality of the laboratory's analytical activities. Some of these checks are as follows:

- Use of certified standards in many of our quality control samples
- Replicate testing using the same test methods
- Participation in Proficiency Testing

2.4 Audit and Review Documentation

All audit records shall be kept on file in the Quality Systems Department Office. These records shall be available for external auditors, as well as, individuals involved in a Managerial Review of the PAES Quality System. This documentation will include:

- Audit Check Sheets
- Audit Report Forms
- Corrective Action Reports

2.5 Corrective Action

An integral part of PAES' Quality Systems Program is the system for identifying, reporting, and correcting deficiencies in the laboratory operation. There are several areas in the laboratory that may require corrective action. It is the responsibility of every employee to be aware of potential problems and to notify the appropriate personnel of situations requiring corrective action.

2.5.1 Problem Isolation and Identification

Identification and isolation of problems in the laboratory are not always easy tasks. The need to perform corrective action may become apparent at any point of the analytical process. Corrective action should be initiated and documented as soon as a problem becomes evident. The analyst at the bench detects some situations such as malfunctioning equipment. Corrective action for these situations takes the form of repairing the instrument, either internally or through the use of a service call. The corrective action is documented in the instrument maintenance log and the data obtained just prior to the failure is closely scrutinized for acceptability.

Other situations may not be easily identifiable. For example, systematic drift or sensitivity fluctuations may not be identified until the time that data is validated. Other occurrences that may trigger the need for corrective action include the following:

- Recoveries for surrogates, matrix spike, matrix spike duplicates, and laboratory control standards outside of acceptance limits.
- Percent differences for duplicate analyses outside acceptance limits.
- Trends noted in quality control data.

Out of control events that concern sample analysis and data generation must be documented in a Case Narrative, which becomes a permanent part of the client's project file and final data report.

2.5.2 Sample Handling Problems

Problems involving sample handling may include missing or broken containers, discrepancies between the chain of custody and actual shipment, improperly preserved bottles, insufficient volume, and missed holding times. When one of these problems is identified, a Non-Conformance Form is completed and acted upon in accordance with the Standard Operating Procedure for Sample Receiving. If necessary, the client is contacted to discuss possible resolutions to the problem. The Non-Conformance Form becomes a part of the client's permanent file.

2.5.3 Sample Analysis Problems

Problems incurred during sample analysis may bring procedures and data into question. These problems may include the following:

- Unacceptable calibration
- Improper procedures
- Unacceptable blank, LCS, and/or surrogate recovery
- Quantitation error
- Required QC not performed
- Retention time shifts

Resolving these problems may include preparing and analyzing the samples a second time, re-calibrating the instrument, or making new standard solutions and reagents. Standard Operating procedures detail corrective action steps that are specific to an analytical procedure. The documentation becomes part of the client's permanent file.

The person identifying the problem documents the situation and identifies possible sources of the problem. If this individual can immediately correct the situation, for example, by re-calibrating the instrument, they will do so and document the action that was taken in the case narrative. If the problem cannot be corrected immediately, the person documents the situation and notifies the Laboratory Manager. The Laboratory Manager is responsible for ensuring that the appropriate corrective actions are followed.

2.5.4 Corrective Action Reports

A Corrective Action Report (CAR) will be completed for each audit deficiency, legitimate issue reported, and any systemic out of control event that occurs. PAES has instituted a procedure for reporting when departures from documented policies, procedures, and quality control have occurred. The CAR is a means for anyone in the company to communicate quality concerns to the Technical Department. These forms are a part of PAES' Quality System, which provide an avenue for all employees to reflect a genuine concern for quality throughout the company. The CAR is also used to document Customer Complaints and initiate the process of resolving those complaints. All items pertaining to the Customer complaint shall be recorded on the CAR including investigation results and resolution to the satisfaction of the client. All Corrective Action Reports that deal with Customer Complaints shall be kept on file in the Quality Systems Department office.

All CAR's will be followed up to ensure that the corrective actions taken have been effective. The Quality Systems Department is responsible for maintaining a supply of forms. To track the corrective action, each CAR will be given a unique identifier in the form of YY-XXXX where:

- YY = the year in which the CAR was initiated and
- XXXX = is the sequential number of the record starting with 0001

2.5.4.1 Corrective Action Report Initiation and Procedures

A Corrective Action Report may be generated by anyone in the company who discovers and can correct a systemic out of control event. There are two types of situations in which an employee will generate a CAR. First, when the root cause is obvious to the person who discovered the out of control event, and secondly when the root cause is not obvious.

In the first situation, the person who discovers an out of control event shall institute and document corrective action by completing the top portion of the CAR (above the dotted line). They will enter their name, the current date, a description of the event that needs corrective action, and the specific corrective action that was taken. The analyst or Department Manager shall be notified of the event and the corrective action necessary to solve the non-conformance. The person who completes the corrective action shall sign the form and forward it to their immediate supervisor for a signature. The form will then be forwarded to the Quality Systems Department for cataloging. If additional action is required, the form shall be returned to the department concerned and returned to the Quality Department when corrective action is complete.

If the root cause is not immediately obvious, the Quality Systems Department shall be notified immediately to assist in Root Cause Analysis and determining the appropriate corrective action.

The Quality Systems Department will forward a copy of the CAR to the Laboratory Manager. If it is determined that the client needs to be notified of the incident, the Quality Systems Department shall forward a copy of the CAR to the Customer Service Department and they shall notify, in writing, any client whose work may have been affected within 48 hours of identifying the problem.

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2.5.4.2 External Audits and Performance Evaluation Studies

The Quality Systems Department will initiate CAR(s) in response to third party audits and deficiencies on performance evaluation studies. In the case of third party audits, if the resolution to the finding is easily identifiable, the Quality Systems Department will discuss the situation with the Laboratory Manager and the corrective action will be implemented. If the finding concerns a procedural change or is interdisciplinary, the Quality Systems Department will form a task team to investigate the problem and develop an appropriate course of action. The task team's findings will be presented to the Quality Systems Department for discussion and possible implementation. Once a corrective action plan is implemented, the situation will be monitored for a reasonable period of time to ensure that the action has been effective.

The Quality Systems Department will prepare a report for management that summarizes all corrective actions (See Figure 2-4). The report will provide a brief description of the problem, the steps that are being taken to correct the situation, and the status of the item.

2.6 Preventive Actions

The preferred course of laboratory quality and improvement is to identify opportunities for improvement rather than react to the occurrence of problems or complaints. PAES is continually seeking ways to improve its performance and product. When these areas are identified, a plan is developed by the department managers. Preventative actions are implemented according to the time table specified in the plan. Preventive action procedures include follow-up actions and applications of controls in order to ensure effectiveness. The laboratory seeks both negative and positive feedback from its customers. Feedback provides acknowledgement, corrective actions when needed, and opportunities for improvement. A statement printed on the front page of all final reports gives an avenue for customers to provide comments to us on our performance. Random surveys may also be used as a
means to gather feedback from customers. This information is forwarded to the Quality Systems Department.

2.7 Management Arrangements for Permitting Departures from Documented Procedures or Standard Specifications

It is PAES management's intent to ensure that documented procedures are followed. Rarely, a situation may occur that requires a departure from documented quality procedures. When this type of situation occurs, the Quality Systems Department and Laboratory Manager, and any other

manager whose department may be affected, will discuss and unanimously agree upon the action to be taken. The departure will be documented in memo form and kept on file in the Quality Systems Department Office. Corrective action will be taken as soon as possible to prevent the necessity of the departure from reoccurring.

Review Date: October 27, 2015

Figure 2-1

Internal Audit Report

Audit Date: _____ **Department:** _____

Auditors: _____

Supervisor: _____ **Employee Present:** _____

Audit Summary:

Areas of Excellence:

Deficiencies:

Suggestions:

Quality Manager: **Date:**

Follow-up evaluation: (use back of sheet, if necessary)

Completed by: **Date:**

Figure 2-2

Root Cause Analysis

Deficiencies are always analyzed from the non-conformance back to the root cause as follows:

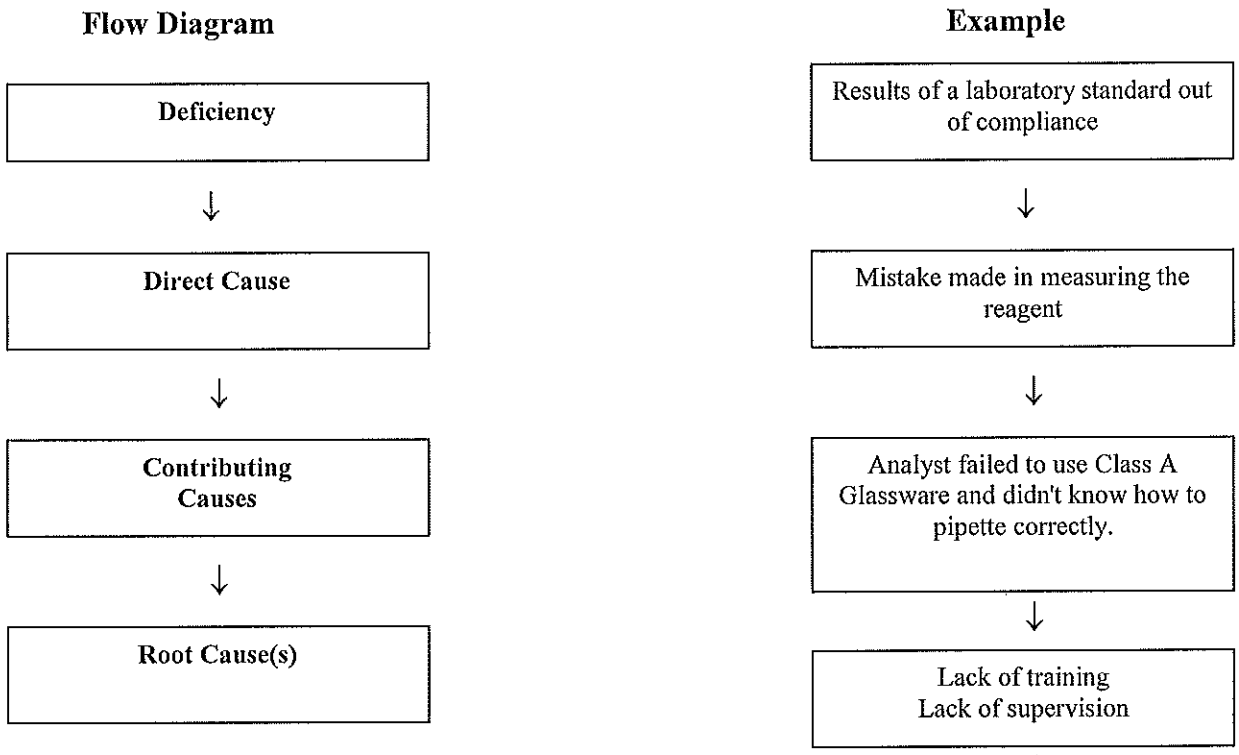

Figure 2-3

Corrective Action Report **CAR#**

Initiated by: **Date:**

Description of the event needing corrective action and corrective action required.

Root Cause:
This Corrective Action must be acted upon in the time frame indicated below:

Immediately ___One Week ___Two Weeks ___ 30 Days_____ Est. Date: _____

Corrective Action Taken: **Due Date:**

Action Completed by: _____ **Date:** _____

Supervisor Review: _____ **Date:** _____

Project #: _____ **Sample Numbers:** _____

Additional Action: is___ is not ___ necessary. Customer Contact: is___ is not ___ necessary.

Action Closed: _____ **Date:** _____

Follow-up evaluation: **Date:** _____ **Completed by:** _____

Figure 2-4

Quality Systems Update and Corrective Action Summary Report **Date:**_____

CAR #	Date	Summary	Resolution	Responsibility

Quality System

PE's:

Internal Audits:

External Audits:

SOP review/revision:

Certification status:

Quality System Manual review/revision:

This report was presented to PAES AGM/GM on _____. The AGM/GM reviewed it and, as necessary, discussed the appropriate directives that would improve the quality system.

Signature: _____ Date: _____

3.0 Organization and Management

Since PAES is a business that must compete in a marketplace characterized by merger and consolidation, it is even more important to have an efficient organization with well-defined responsibilities. The purpose of this section is to describe the organization and management structure of PAES, interdepartmental and intradepartmental relationships, and to detail employee responsibilities and qualifications.

3.1 PAES Organization

Organizations must have a framework within which to achieve their objectives. Organizational structure determines the configuration of positions, duties, and channels through which performance is controlled and authority is delegated. It is crucial that a company use a structure that enables it to realize competitive advantages.

In order for PAES to achieve its stated objectives for the quality of its analytical services, all employees must be able to function within a structure that provides an emphasis on quality from a technical standpoint. A functional organizational structure is specifically suited to this purpose.

3.1.1 Organizational Structure

PAES' organizational structure is functional. This type of structure is centralized, which restricts decision-making authority to higher levels of management. Company organization is departmental and is specialized and arranged according to function. The Quality Systems Department reports directly to the Assistant General Manager. PAES' Organizational Chart is depicted in Figure 3-1.

3.1.2 Interdepartmental Relationships

Responsibility and dedication to quality laboratory practices and procedures begin at the highest level of management. It is the duty of Senior Management to assure that the framework is in place to provide quality systems guidelines. It is the duty of PAES managers to implement the policies and procedures and to see that they drive the activities of the laboratory.

3.1.2.1 Natural Attenuation Services

The Laboratory Manager oversees all analytical departments responsible for providing analyses to support natural attenuation monitoring. The Laboratory Manager works with the analytical work groups in the laboratory to meet quality and turnaround objectives. The Manager for IC analyses coordinates the activities for analysts responsible for anion, cation, and LLVFA determinations. This responsibility includes final review of raw and QC data. The Laboratory Manager has direct supervision for analysts involved with determinations for wet chemistry parameters, volatile organics, fatty acids by GC, and dissolved and permanent gas determinations. His position includes data review, final report technical review, and implementation of the QC program.

3.1.2.2 CSIA Services

The Director of CSIA services directs the activities of the CSIA analytical staff in regards to routine analytical procedures and method development for isotope analyses.

3.1.2.3 Petroleum Forensics Services

The Assistant General Manager has direct supervision for the analysts in the forensics department.

3.1.2.4 Molecular Diagnostics Services

The Assistant General Manager has direct supervision for the analysts in the molecular diagnostics department.

3.1.2.5 Client Services

The Client Services department serves as a liason between the customer and laboratory staff. Personnel within the department provide quotes, prepare and ship bottle orders, and perform completion review of final reports.

3.1.2.6 Quality Systems Department

The Quality Systems Department operates outside of the scope of the analytical departments in lines of authority. Responsibility for the Quality Systems Department falls upon the Quality Systems Manager who reports directly to the General Manager. The Quality Systems Manager is responsible for the development, implementation, communication and maintenance of quality systems policies and procedures. A primary goal is to achieve joint cooperation of the operational functions within the company while addressing regulatory requirements in an effective, timely and responsible manner.

The Quality Systems Department is administratively responsible for quality assurance and quality control, and may serve as the Quality Systems Manager's representative in his absence.

3.1.3 Intradepartmental Relationships

The Quality Systems department has a quality assurance and quality control role to fulfill within each department at PAES. Discrepancies in quality in any department will be relayed from the Quality Systems Manager to the appropriate department using a format that is appropriate for the type of discrepancy and recommending an appropriate corrective action using a Corrective Action Report.

3.2 Personnel Qualifications

All of PAES employees are responsible for complying with the applicable job specific quality assurance and quality control requirements. All staff are to familiarize themselves with the quality documentation and implement the policies and procedures contained in this Manual in their work. Each staff member, including contracted and additional technical and key support personnel should they be required, must demonstrate a combination of formal education and experience to satisfactorily perform their particular function, as well as, a general knowledge of laboratory operation, quality assurance, quality control, test methods, and records management. All personnel are placed in a work group or department with adequate supervision that ensures the employee works in accordance with the laboratory's Quality System. Documentation of employee proficiency for specific job functions and test methods is maintained in the Quality Assurance Analyst's Office.

The Laboratory Manager, based upon specific educational and experience requirements, makes laboratory job assignments. Laboratory analysts are assigned a job classification according to the level of formal education and related laboratory experience they possess.

Basic duties of key staff (those included in Figure 3-1) are discussed below. Complete job descriptions for some key staff are contained in Appendix A of this Quality Systems Manual.

3.2.1 Director of Business Integration/General Manager

The Director of Business Integration/General Manager is responsible for overall company performance. He is responsible for new business development and the financial integrity of the company. Additionally, he approves capital expenditures and evaluates current market conditions to maintain the laboratory's competitiveness.

3.2.2 Director of Specialty Services

The Director of Specialty Services works closely with the Director of Business Integration/General Manager to identify potential new markets and shares the responsibility for the financial integrity of the laboratory with the Director of Business Integration/General Manager.

3.2.3 Assistant General Manager

The Assistant General Manager is responsible for day to day operations of the laboratory, ensuring policies and procedures are adhered to as well as being the point of contact for the Director of Business Integration/General Manager.

3.2.4 Director of CSIA Services

The Director of CSIA Services is responsible for implementing and enforcing laboratory policies and procedures within the CSIA department. He is responsible for the daily operation of the CSIA analytical department and is responsible for overseeing the routine expenditures in the CSIA department.

3.2.5 Laboratory Manager

The Laboratory Manager is responsible for ensuring that PAES' goals of providing accurate and verifiable analyses are met. It is the Laboratory Manager's responsibility to ensure that all analytical personnel have the required qualifications and training for their positions. Once qualified personnel are in place, the Laboratory Manager, in conjunction with the Quality Department, will be responsible for assuring that all employees are thoroughly familiar with the Quality Systems Manual and accepted laboratory practices. The Laboratory Manager oversees the daily management of the laboratory staff. A major component of this particular responsibility is the integrity of laboratory reports. The Laboratory Manager, or a qualified designee will review and approve all outgoing reports. In the absence of the Laboratory Manager, the Assistant General Manager will assume these responsibilities.

3.2.6 Quality Systems Manager

The Quality Systems Manager is ultimately responsible for ensuring that the data produced by the laboratory are technically sound and of the highest quality possible. The Quality Systems Manager serves as the focal point for quality assurance and quality control and is responsible for the oversight and/or review of quality control data. This position notifies laboratory management of deficiencies in the quality system and monitors corrective action. The Quality Systems Manager reports directly to the General Manager.

3.2.7 Manager of Client Services

The Manager of Client Services provides direction and supervision to ensure that clients receive the best service possible. This position reviews proposal submittals and proposes pricing strategies for potential projects. This position reports to the Assistant General Manager.

3.2.8 Quality Assurance Analyst

The Quality Assurance Analyst assists the Quality Systems Manager to ensure that PAES Quality Systems Policies and Procedures are being followed. This is accomplished by: (1) Reviewing data validation procedures; (2) Alerting the analysts should the need for corrective action exist; (3) Performing internal audits; (4) Establishing a periodic schedule for analyzing performance evaluation samples; and (5) Maintaining Quality Control records. The Quality Assurance Analyst reports to the Quality Systems Manager.

3.2.9 Sample Receiving Client Service Tech

The Sample Receiving Client Service Tech is responsible for properly receiving and logging-in all samples received at PAES and ensuring that storage and documentation requirements are met. This position also unpacks and marks the samples with the correct internal laboratory identification number so that the client's samples can be tracked through the laboratory. The Sample Receiving

Client Service Tech is responsible for documenting all discrepancies between samples received and accompanying chains of custody and for notifying customer service so that the client may be contacted. The Sample Receiving Client Service Tech reports to the Manager of Client Services.

3.2.10 Laboratory Analyst

Laboratory Analysts are responsible for retrieving samples from Sample Receiving and observing all internal custody requirements. The analysts shall ensure that aliquots analyzed are representative of the entire sample. All analyses shall be conducted according to PAES Standard Operating Procedures. Responsibilities also include following good laboratory practices in carrying out duties assigned, and complying with all safety regulations applicable to their respective laboratories. Analysts report directly to the Lab Manager.

3.2.11 Project Manager

The Project Manager is responsible for overseeing in-house analytical projects. It is the Project Manager's responsibility to accurately communicate project requirements to the Laboratory Manager so that projects are logged-in, analyzed, and reported in the format, timeframe, and within the project-specific protocols required by the client. This position reports to the Manager of Client Services.

3.2.12 Bottle Preparation Client Service Tech

The Bottle Preparation Client Service Tech is responsible for accurately preparing sample containers in a timely and safe manner according to client specification. The Bottle Preparation Client Service Tech also maintains records of standing orders and ensures they are prepared for the courier and for shipment when appropriate. This position also prepares purchase orders for ordering supplies as needed. The Bottle Preparation Client Service Tech also maintains the Bottle Preparation room and storage area in a neat and orderly manner. This position reports to the Manager of Client Services.

3.3 Contract Review, Design Control, and Quality Planning

The Client Services Department shall start the review of all new work that comes in to the laboratory. Appropriate sections of any request for work shall be reviewed by each department concerned to determine if PAES has adequate facilities and resources to complete the work in the contract appointed time frame. Each department is to indicate whether their department can or cannot meet the contract requirements, via email to the Customer Service Office. If a department cannot meet the requirements of the contract or scope of work, the department is to indicate the reason(s) for that decision.

The client shall be informed and a resolution discussed if the laboratory review of capability indicates any potential conflict, deficiency, lack of accreditation status, or inability on the

laboratory's part to complete the clients work. Any differences shall be resolved to the satisfaction of the laboratory and the client prior to commencement of work.

All contract documents are forwarded to the Corporate Counsel for review. Any exceptions or suggestions with the contract language noted by the Counsel will be forwarded to the client for their approval. Once a mutually acceptable agreement is reached, the General Manager or their designee with approval, will sign the contract and/or purchase order.

In the event that the contract needs amended after work has commenced, the same contract review procedures shall be repeated and any changes shall be communicated to all affected personnel.

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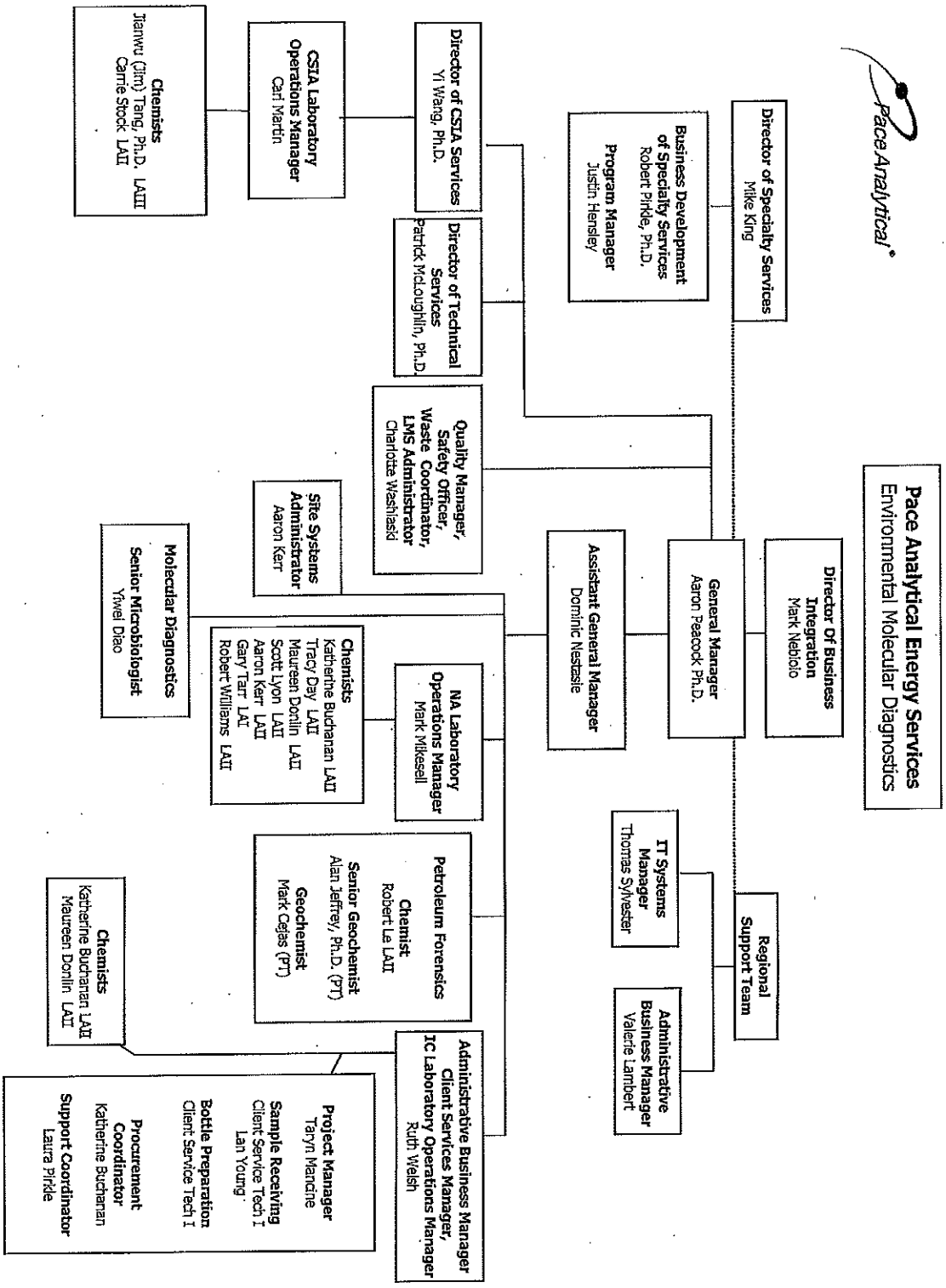
Pace Analytical
Pace Analytical Energy Services
Environmental Molecular Diagnostics
Director of Specialty Services
Mike King
Director Of Business Integration
Mark Nebiolo
General Manager
Aaron Peacock Ph.D.
Assistant General Manager
Dominic Nastasie
Business Development of Specialty Services
Robert Pirkle, Ph.D.
Program Manager
Justin Hensley
Director of CSIA Services
Yi Wang, Ph.D.
Director of Technical Services
Patrick McLoughlin, Ph.D.
CSIA Laboratory Operations Manager
Carl Martin
Chemists
Jianwu (Jim) Tang, Ph.D. LAIII
Carrie Stock LAII
Quality Manager, Safety Officer, Waste Coordinator, LMS Administrator
Charlotte Washiaski
Site Systems Administrator
Aaron Kerr
Molecular Diagnostics
Senior Microbiologist
Yiwei Diao
Chemists
Katherine Buchanan LAII
Tracy Day LAII
Maureen Donlin LAII
Scott Lyon LAII
Aaron Kerr LAII
Gary Tarr LAI
Robert Williams LAII
NA Laboratory Operations Manager
Mark Mikesell
Petroleum Forensics
Chemist
Robert Le LAII
Senior Geochemist
Alan Jeffrey, Ph.D. (PT)
Geochemist
Mark Cejas (PT)
IT Systems Manager
Thomas Sylvester
Regional Support Team
Administrative Business Manager
Valerie Lambert
Administrative Business Manager
Client Services Manager,
IC Laboratory Operations Manager
Ruth Welsh
Chemists
Katherine Buchanan LAII
Maureen Donlin LAII
Project Manager
Taryn Mancine
Sample Receiving
Client Service Tech I
Lan Young
Bottle Preparation
Client Service Tech I
Procurement Coordinator
Katherine Buchanan
Support Coordinator
Laura Pirkle
Last Revised – October 27, 2015
Last Reviewed –October 27, 2015

Figure 3-1

4.0 Sample Management

The purpose of this section is to outline and reference procedures for the type and use of sample containers, the preservation of the samples, sample shipping, sample receipt, sample custody, sample log in, sample disposal, and analytical subcontracting. A list of analytical procedures conducted by PAES is found in Tables 4-1 and 4-2 at the end of this section. Certifications are found in Table 4-3.

4.1 Sample Containers and Preservation

In order to provide the best possible service for the client and to obtain the required sample volume, PAES prefers to provide the sampling containers. Sample containers are constructed of either polyethylene or glass. Containers are purchased that are pre-cleaned and ready for use. Certified clean containers can be provided if project specifications require. Preservatives are added to most sample containers prior to shipping to the client, either by the bottle preparation client service tech, or the by the vendor. Clients are encouraged to completely fill each container in order to provide adequate sample volume.

For DoD projects: All bottles, reagents, solvents, and supplies used in DoD projects will be verified or certified by the supplier to meet or exceed standard specifications for environmental tests concerned. Verification must be kept on file to qualify each bottle, reagent, solvent and supply.

4.2 Sample Packing and Shipping

Samples are either hand carried to the laboratory or shipped using commercial carriers. Samples should always be shipped to the laboratory daily using a reliable overnight shipping service.

The chain of custody is used to establish the identity of samples and to provide proof of possession of the samples by PAES. Chains of custody are supplied to the client with the sample bottle order. The following information should be recorded, by the client, on the chain of custody.

- Client Name, Address, and Phone Number
- Project Name
- Project Number
- Sample Identification, Collection Date and Time, Number of Containers
- Specific Analytical Requirements
- Sample Matrix
- To whom the analytical data shall be submitted
- Relinquish signature

Ice should be added so that a temperature of above freezing but $\leq 6^{\circ}C$ is maintained during shipment. Samples should be packed inside a large bag and the bag should be sealed. Bags of ice

should be placed on top of the bag and should not be in direct contact with the sample containers. Cooler temperatures are taken electronically and recorded upon receipt by the laboratory.

The chain of custody should be enclosed in the zip lock bag, and taped to the inside lid of the cooler.

A copy of PAES' Sample Acceptance Policy is included with each client bottle order (see below). In order to expedite the sample log in process, please be sure to include and accurately complete all paperwork that should accompany samples to the laboratory.

Sample Acceptance Policy

1. Samples that are shipped to PAES must be accompanied by proper, full, and complete documentation. This documentation shall be marked on a chain of custody and shall include: sample identification, the location, date and time of collection, sampler's name, preservation type, sample type, specific parameters to be analyzed, and any special remarks concerning the sample.

2. Sample labels shall be supplied by PAES or the client. Those labels must be water resistant and completed using indelible ink. Each sample label must include a unique identification number that links it to the chain of custody documentation.

3. Samples shall be in the proper containers with the preservatives that are specific to the type of analysis required.

4. All samples must be received within specified holding times. Clients are requested to notify a PAES' Customer Service Representative if samples with short holding times are being shipped.

5. Samples must arrive at PAES with sufficient volume to conduct the requested analyses. All bottles should be filled completely.

6. When problems with samples or documentation are found during the sample receiving process, a Non-Conformance Form is completed by the Sample Custodian and forwarded to the Customer Service Office. A Customer Service Representative will make every attempt to contact the client as soon as possible to make decisions concerning those discrepancies. The Non-Conformance Form is kept as a permanent part of the project file.

7. If the client cannot be reached, a message will be left either on voice mail, with a receptionist, or via email for the client to return the phone call. The samples will be placed in a storage refrigerator and held until a PAES' Customer Service Representative gets a response from the client. (Exceptions will be made when samples are received that have short holding times and the samples are from a client with whom PAES has regular and frequent dealings. Or when the samples have short holding times and the samples are from a client with whom PAES has a signed contract, work order, or purchase order.)

4.3 Sample Custody

PAES takes custody of the samples when they are received at the laboratory or picked up at a client site by a PAES' employee. All samples are maintained in access-controlled areas until work is

started. The person responsible for either the sample preparation or analysis will retrieve the sample(s) from the storage area and return them when the function is complete.

4.3.1 Samples Requiring Secure Storage

For samples requiring locked storage and strict custody protocols (e.g. samples as evidence), the samples are locked in a temperature controlled sample storage cooler. When evidentiary samples are to be analyzed, the Sample Receiving Client Service Tech initiates a sample tracking record (Figure 4-2), and the analyst signs them out using the complete sample number as generated by the LIMS to identify the samples taken.

After analysis, all remaining sample, sample extracts, or the empty sample container are returned to secure storage, signed back in on the sample tracking record, and placed back in the secure storage area. Entries are made to the form each time a sample is removed and returned to the storage areas. Whenever sample preparations are completed, the sample preparation group adds them to the tracking record. All records of evidentiary samples are maintained until the client authorizes destruction.

4.3.2 Sample Receipt Protocols

The Sample Receiving Client Service Tech, or designee, signs for each shipment, and a copy of the shipping documents is retained. Specific sample receipt procedures are addressed in PAES Standard Operating Procedure for Sample Receipt. A brief outline follows:

- Shipment containers are inspected, opened, and monitored for temperature, if applicable.
- Temperature is recorded on the Chain of Custody.
- Shipment containers are unpacked and samples reconciled with the chain of custody.
- Chain of Custody is signed.
- Non-conformances are resolved with the client.
- Samples are logged in to PAES LIMS system.

Specific sample log in procedures are outlined in PAES Standard Operating Procedure for HORIZON LIMS. PAES LIMS assigns a unique internal project number and sequential sample numbers. These numbers are used to track the project through the laboratory. The sample numbers are transferred to each sample container using a computer-generated label. These numbers are documented on the chain of custody form and verified by the Sample Receiving Client Service Tech. A cooler receipt form is generated and placed in the project file along with the chain of custody and other related documentation.

All documentation relating to the project is maintained in the project file and retained in the laboratory for five years following the date the project is completed.

4.3.3 Resolution of Non-conformances

Sample receipt non-conformances are resolved according to PAES Standard Operation Procedure for Sample Receipt (SOP-S2). In nearly all cases, the client is contacted for the resolution decision and documentation.

Several possibilities may exist for resolving sample receipt problems. All decisions are the client's responsibility. Once a resolution is determined, the solution is noted on the non-conformance form and one or more of the following actions will occur:

- The log-in process will continue
- Written documentation will be requested from the client
- The sample(s) will be returned
- The sample(s) will be disposed

Throughout the problem resolution process, the sample will either be kept in a secure area or will be in view of the sample receipt personnel. All records generated during this process become a part of the client's permanent file.

When a client decides to proceed with analyses of samples that do not meet acceptance criteria, that decision shall be fully documented on the non-conformance form and the analysis data shall be "qualified" using a narrative on the final data report.

4.4 Sample Storage and Recovery

Samples requiring refrigeration are placed into temperature-controlled coolers that are maintained above freezing but $\leq 6°C$. The cooler temperature is recorded each working day. The walk-in cooler, volatiles storage cooler, and CSIA storage cooler, use a Min/Max thermometer, and are recorded once a day. Temperature logs are maintained for each cooler.

All samples for volatile analysis are segregated in a cooler away from other samples. All samples are stored separately from standards, reagents, food, and other potentially contaminating sources.

4.5 Sample Disposal

Once samples are analyzed, they are moved from a primary to a secondary storage area. Samples are stored in secondary storage areas for thirty days following the date an analytical report is generated. Samples are disposed or returned according to the procedures outlined in the PAES Standard Operating Procedure for Waste Disposal.

4.6 Subcontracting Analytical Samples

PAES' Laboratory Manager or designee will notify the Project Manager when samples or extracts need to be sent to a subcontract laboratory, the number of samples to be sent, and the duration of the need for subcontract services for services routinely provided at the PAES facility. The Project Manager will notify the client in writing of the intent to subcontract samples. The Project Manager

will schedule the work with the subcontract laboratory and arrange the specifics of shipping the samples.

The Project Manager shall monitor the progress of the analytical work and receive the analytical data from the subcontract laboratory.

In the event of expedited turnaround that cannot be met by PAES, the Project Manager shall initiate the subcontract laboratory procedure in order to meet the client's need.

4.6.1 Subcontract Laboratory Approval

The following procedures are in place to ensure that laboratories that are to be used for subcontracting analytical samples meet minimum requirements for quality as specified by the Quality Systems Department. Prior to approval of a subcontract laboratory, the Quality Systems Department shall request the following information from the laboratory:

- List of current certifications and expiration dates of each.
- Copy of the Quality Assurance Plan for the subcontract facility.

Once this material has been received, it shall be reviewed by the Quality Systems Department and a decision will be made concerning the approval of the subcontract laboratory.

For DoD projects: All subcontracting of DoD projects will be to approved DoD laboratories.

4.6.2 Client Notification of Subcontract Laboratory

There are various reasons why a subcontract laboratory may be used including, but not limited to, an expedited turnaround time, laboratory capacity, and special analysis. All clients shall be notified in writing when any samples are to be sent to a subcontract laboratory.

Where the laboratory subcontracts any part of the testing that is covered under NELAC, this work shall be subcontracted to a NELAC accredited laboratory. The laboratory performing the subcontracted work is indicated on the final report and non-NELAC accredited work is clearly identified.

TABLE 4-1

Container, Preservation, and Holding Time Requirements
(EPA Methods for Chemical Analysis of Water and Wastes Table I and SW-846 3rd ed. Revision 4, Tables 2-40A, 2-40B)

Parameter	**Method**	**Container** (1)	**Preservative** (2)(3)	**Maximum Holding Time** (4)
Anions by IC	SW846-9056	G, VOA with butyl septa	Cool to above freezing but ≤6°C, unpreserved	48 hours for NO_2, NO_3 28 days for other anions
TOC/DOC	SW846-9060 SM 5310 C	P	Cool to above freezing but ≤6°C , H_2SO_4 to pH< 2	28 days
pH	SM 4500 H+	P	Cool to above freezing but ≤6°C	Immediate

1. AG - amber glass, G - glass, P – polyethylene.
2. Sample preservation should be performed immediately upon sample collection. Composite samples may be preserved by maintaining at ≤6°C until sample splitting and collection is completed.
3. If the dissolved content is to be measured, samples should be filtered on site immediately before adding preservatives.
4. The holding times listed are the maximum times that samples may be held before analysis and still be considered valid under EPA regulations. Holding times are measured from the time the sample is collected.

Table 4-2

Bioremediation Indicator Parameters and Risk Analysis Test Methods
These parameters are analyzed using PAES' Methods.

Parameter	Method	Container	Preservative	Maximum Holding Time
Hydrogen by Bubble Strip	SM9/AM20Gax	22 cc vapor vial with stopper septum	None	14 days
Light hydrocarbons by Bubble Strip	SM9/AM20Gax	22 cc vapor vial with stopper septum	None	14 days
Permanent gases by Bubble Strip	SM9/AM20Gax	22 cc vapor vial with stopper septum	None	14 days
Light hydrocarbons in water: Methane, Ethane Ethene	PM01/AM20Gax RSK-175	40 ml Clear VOA vial with butyl septum	Trisodium Phosphate or Benzalkonium Chloride & Cool to above freezing but ≤6°C	14 days
Permanent gases in water: Oxygen, Nitrogen, Carbon Dioxide	PM01/AM20Gax	40 ml Amber VOA vial with butyl septum	Benzalkonium Chloride & Cool to above freezing but ≤6°C	14 days
Light hydrocarbons in vapor	AM20Gax	22 cc vapor vial with flat septum	None	14 days
Permanent gases in vapor	AM20Gax	22 cc vapor vial with flat septum	None	14 days
Hydrocarbons in vapor	AM4.02	22 cc vapor vial with flat septum	None	Unspecified
Chlorinated hydrocarbons in vapor	AM4.02	22 cc vapor vial with flat septum	None	Unspecified
Total inorganic carbon in water	PM01/AM20Gax	40 ml Clear VOA vial with butyl septum	Cool to above freezing but ≤6°C	14 days
Volatile Fatty Acids	AM21G	40 ml Clear	Cool to above freezing but ≤6°C	21 days
Low Level VFA	AM23G	40 ml Amber with butyl septum	Cool to above freezing but ≤6°C Benzalkonium chloride	14 days

Table 4-2
Petroleum Forensics Methods

Analysis	Method	Container	Preservative	Maximum Holding Time
Parent and Alkylated PAHs	8270(SIM) Modified	P - 2 x 40ml VOA Vials S - 1 x 4oz jar W – 2 x 1L Glass	Unpreserved Ice, maintained at 6°C	Unlimited If solid or water – 14 days.
C3-C36 Whole Oil	ASTM D3328 (GC/FID)	2 x 40ml VOA Vials	Unpreserved	Unlimited Cannot analyze on water or soils
C8-C40 Full Scan	ASTM D5739 (GC/MS)	P – 2 x 40ml VOA Vials S – 1 x 4oz jar W – 2 x 1L Glass	P – NONE S or W – ice, maintained at 6°C	Unlimited If solid or water – 14 days.
Simulated Distillation	ASTM 2887	2 x 40ml VOA Vials	NONE	Unlimited Cannot analyze on water or soils
Oxygenated Blending Agents	EPA 1624 Modified	2x40mL VOA vials W – 2x40mL VOA vials	P – NONE W – HCL; ice, maintained at 6°C	Unlimited If water – 14 days
Organic Lead and Lead Scavengers	GC/ECD	2x40mL VOA vials	NONE	Unlimited Cannot analyze on water or soils
C3-C10 PIANO	GC/MS	2x40mL VOA vials W – 2x40mL VOA vials S – 1 x 4oz jar	P – NONE W – HCL; ice, maintained at 6°C	Unlimited If solid or water – 14 days

Table 4-2
Molecular Diagnostics Methods

Analysis	Method	Container	Preservative	Maximum Holding Time
BER Array	SOP for BER Array	S-1x4oz jar S-1x50mL Falcon tube W-1x1 filtration tube	Unpreserved Ship on ice Maintain at -20°C	Unlimited
Target Species present test	SOP for PCR	S-1x4oz jar S-1x50mL Falcon tube W-1x1 filtration tube	Unpreserved Ship on ice Maintain at -20°C	Unlimited
Target Genes present test	SOP for PCR	S-1x4oz jar S-1x50mL Falcon tube W-1x1 filtration tube	Unpreserved Ship on ice Maintain at -20°C	Unlimited
Target Species quantity test	SOP for QPCR	S-1x4oz jar S-1x50mL Falcon tube W-1x1 filtration tube	Unpreserved Ship on ice Maintain at -20°C	Unlimited
Target Genes quantity test	SOP for QPCR	S-1x4oz jar S-1x50mL Falcon tube W-1x1 filtration tube	Unpreserved Ship on ice Maintain at -20°C	Unlimited

Table 4-3

NELAC Accredited Parameters/Methods

Primary NELAC: Pennsylvania
Secondary NELAC: NY, NJ, NH, VA, CT, SC, TX, WV
(Not all states accredit all parameters.)

Parameter	Method
Chloride	SW846-9056
Nitrate	SW846-9056
Nitrite	SW846-9056
Sulfate	SW846-9056
TOC/DOC	SW846-9060, SM 5310C
pH	SM 4500H+
Light Hydrocarbons	RSK175M
Volatile Fatty Acids	PAES SOP-AM23G

Call Quality Department for state-specific analyte list.

Figure 4-1
Chain of Custody Form

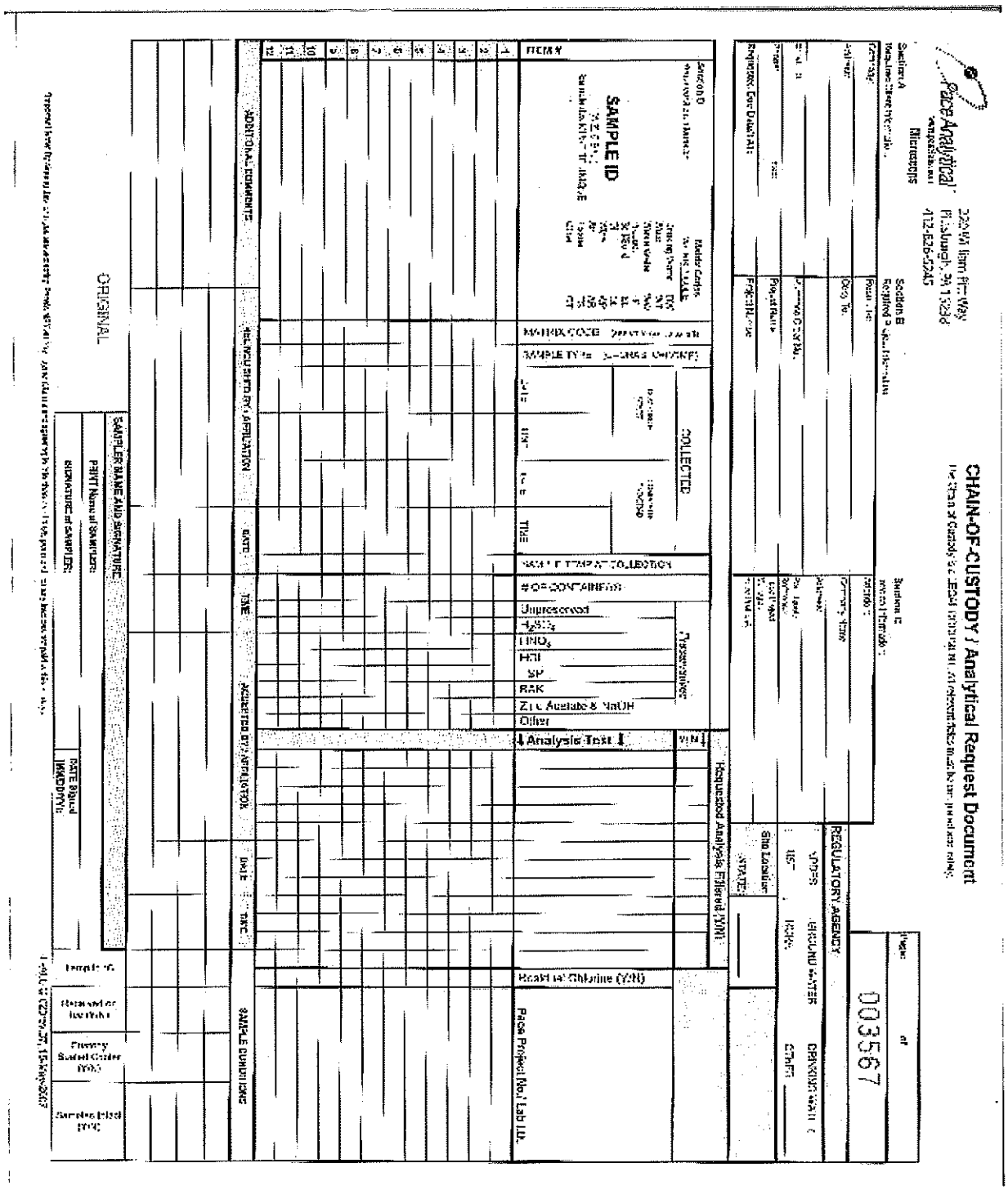

Figure 4-2

Sample Tracking Record

Client Name: _____ **Page** _____ **of** _____

Client Project Number: _____

Bottle Type Circle or Highlight (Sample Receiving Only)							
	Cations	Nutrient	TIC	VFA			
	G. Chem.	VOA	Soils	LLVFA			
	TOC/DOC	Petro	Diss. Gas	Hydrogen			
	Anions	Micro	Vapor	CSIA			

Sample Receiving only to mark above dotted line

Sample Numbers	**Removed from Storage**			**Bottle**	**Returned or Placed in Storage**		
	By	**Date**	**Time**	**Type**	**By**	**Date**	**Time**

Enter Bottle Type From List Above In Proper Column

5.0 Facilities, Instrumentation, and Materials Procurement

5.1 Facility Description

Pace Analytical Energy Services (PAES) is located in the University of Pittsburgh's Applied Research Center (UPARC). The complex consists of 58 separate buildings, which house over 120 companies. The Oxford Development Company provides management for the UPARC facility including building maintenance and safety support. Oxford Development's maintenance personnel are on-site and respond quickly and efficiently to all internal environmental or air quality issues. Specialized maintenance staff is on-call to respond to ventilation, heating, cooling, lighting, or other problems that may occur.

Laboratory temperatures are controlled by the permanent heating and air-conditioning systems in the UPARC complex. Where the cooling systems have not been efficient enough to maintain correct temperature and humidity requirements for proper instrument function, PAES has installed additional units as needed.

When environmental conditions jeopardize the results of environmental tests, the analyst shall notify the Laboratory Manager immediately of the problem. If the problem cannot be resolved immediately the Laboratory Manager shall order a stoppage of all work until either the problem is resolved, or another area of the laboratory can be utilized to continue testing.

PAES is located in Building B-1 and has offices and laboratories on the first, second, third and fourth floors.

5.1.2 Laboratory Areas

The following table specifies the locations of the individual laboratories and workspaces in the building in which PAES is housed.

First Floor

- Bottle Preparation — Room 108
- Sample Receiving — Room 115/117
- CSIA Laboratory — Room 126/128
- CSIA Laboratory — Room 127

Second Floor

- Dissolved Gas Laboratory — Room 220/222
- Vapor Laboratory — Room 221
- Instrument Laboratory/Wet Chemistry — Room 213
- LIMS Center — Room 218

Third Floor

- Molecular Diagnostics Laboratory — Room 306/308

Fourth Floor

- CSIA Laboratory — Room 424/426
- Petroleum Forensics Laboratory — Room 425

5.1.3 Building and Laboratory Security

Employee access into the UPARC complex is controlled through key-card turn-styles where each individual that works in the complex has a unique code for entry. UPARC Security is aware of who is on-site or off-site at any given time. PAES laboratory areas are controlled through keyed entry to prevent employees from other firms housed in the complex from gaining access to PAES laboratories. Each employee is issued a key that will open doors to rooms occupied by PAES. During normal working hours, the laboratory areas are kept unlocked. After normal business hours the rooms are locked to prevent unauthorized personnel entry.

A UPARC Security Force monitors the facility twenty-four hours a day with a series of video cameras. The guards also make rounds by foot and vehicle during afternoon and night shifts. Visitors cannot gain access to the complex except through the Main Security Gate. All visitors are required to register at the main gate and obtain a visitor's pass before entering the complex. UPARC Security notifies PAES upon the visitor's arrival to verify admittance. Visitors are directed to PAES Reception Office. The visitor is then escorted, by a PAES employee to the PAES front office to sign the visitors log, and is then directed to the employee or laboratory they intend to visit.

5.2 Instrumentation

Instrumentation must be properly calibrated and maintained to produce reliable and reproducible results. This section of the Quality Systems manual defines minimally acceptable standards for installation, calibration, and maintenance of analytical instruments used in the laboratory. Fully detailed procedures are instrument specific and are available in the individual instruments' Operator Manuals.

A list of PAES' Instrumentation is included in Figure 5-1. This list is updated whenever equipment is placed in service or removed from service.

5.2.1 Installation and Set-up

All new instrumentation must be included in the Quality Systems program prior to being used for sample analysis. When new equipment is ordered, the Laboratory Manager and the Technical Director determine the preparations that the laboratory must make to accommodate the equipment. This plan includes descriptions of facility modifications that may be required, personnel

responsible for installation (manufacturer or PAES employee), performance criteria that need to be met, and training procedures that will be followed.

Data generated during installation and set-up will be included in the maintenance log for the instrument. This data may become important later for troubleshooting and diagnostic checks. Operator manuals supplied by the manufacturer are maintained in the laboratory for reference.

5.2.2 Calibration

Calibration procedures for instrumentation are thoroughly documented and routinely followed to provide assurance that the data produced are reliable and accurate. Specific calibration procedures and frequency are detailed in the individual Standard Operating Procedures.

Initial calibration involves comparing instrumental response to various concentration levels of the analytes of interest. The calibration curve will contain a minimum of five points (or better), excluding a blank. The lowest point of the curve should be equal to or lower than the reporting limit. The most concentrated standard should be below but near the upper concentration limit of the linear range. All standards are prepared from solutions of certified concentrations. All calibrations are checked against a "second source" obtained from, preferably a different vendor, but at least a different lot. All calibrations are followed by an initial calibration blank to verify that system contaminants and carry-over are not present. For organic analyses, surrogates are added to each blank and standard. In addition, internal standards are also added for some organic analyses.

If the initial instrument calibration results are outside established acceptance criteria, corrective actions are performed. These criteria and the corrective action are specified in individual Standard Operating Procedures. Data associated with unacceptable initial instrument calibration is not reported.

5.2.2.1 Calibration Verification

If an initial instrument calibration is not performed on the day of analysis, the validity of the initial calibration is verified prior to sample analysis by running continuing instrument calibration verification standards with each analytical batch. Continuing instrument calibration verifications must be run at the beginning and end of each analytical batch.

5.2.3 Instrument Maintenance

Maintenance of analytical instruments is carried out under the direction of the Laboratory Manager and may include regularly scheduled preventive maintenance, or maintenance on an as-needed basis due to instrument malfunction. Maintenance activities for instrumentation are documented in Instrument Maintenance Logs. This documentation becomes a part of the laboratory's permanent records.

Regular maintenance of support equipment, such as balances, thermometers, and fume hoods is conducted annually and more often if required. Maintenance on other support equipment, such as

ovens and refrigerators is conducted on an as needed basis. The analysts are responsible for ensuring that temperatures of ovens and refrigerators are checked and recorded twice daily. The Laboratory Manager is notified if the temperature is outside of the range of use of the specific piece of support equipment, and the equipment is scheduled for maintenance.

Records of maintenance to support equipment are also documented in Maintenance Logbooks. Each piece of support equipment does not necessarily have its own logbook. Maintenance logbooks may be shared with equipment that is housed in the same laboratory area.

5.2.3.1 Out of Service Instruments

In the event that an instrument cannot be calibrated or is determined to be out of order, an out of service or out of calibration tag is placed on it. The analyst is responsible for ensuring the equipment is tagged. This tag shall be removed when the instrument is repaired and ready for use.

5.2.3.2 Instrument Repair

Unexpected repairs resulting from instrument failure are scheduled immediately after the malfunction is observed. Instrument failures are detected through direct observations and by evaluation of the response of verification standards throughout the analytical run. The Instrumentation Specialist is responsible for deciding if laboratory personnel can make the repair or if an outside contractor is required.

Data obtained during instrument failure are not entered into the LIMS for reporting to the client. Complete records of the repairs are maintained in the Instrument Maintenance Logbooks. These records may include notes taken by laboratory personnel during repair and a copy of the service call record. Acceptable instrument performance must be verified before samples can be analyzed.

5.3 Materials Procurement

The purpose of this section is to define requirements for the procurement of materials needed to support laboratory operations.

5.3.1 Purchase of Laboratory materials/Supplies

The laboratory shall purchase necessary supplies by recognizing that all items used in the performance and successful completion of an accurate analysis fall into two categories:

1. **Hardware and Associated Durable Equipment**

These laboratory materials would be those associated to the physical components needed to successfully operate the appropriate analyzer for any given test or set of tests. These materials, more often than not, will be purchased directly from the manufacturer of the analyzer. In such cases where vital materials have been discontinued or become available from an alternate source, the laboratory may purchase such items from other vendors. The providers of such materials will

not be evaluated by any documented procedure or collection of associated quality documents. All materials required in this category must first be approved by the Laboratory Manger(s), Technical Director . Ultimately the successful completion of accurate testing, around the requirements of each individual analytical Standard Operating Procedure, shall determine each vendor's acceptance in this category.

2. Reference Materials and Consumable Laboratory Supplies

These laboratory materials would be those associated to the direct determination of unknown target analyte concentrations present in the samples collected and submitted by our customers. These materials can be purchased from a wide variety of suppliers. The laboratory shall maintain a list of acceptable vendors from which these materials can be purchased. Each vendor in this category shall undergo an initial acceptance procedure and annual renewal by the Quality Systems Department. The Procurement Coordinator will ensure that each vendor provide adequate documentation such that the laboratory can assure a level of conformance with industry guidelines. Such documentation could be related to, but not limited to, a vendor's ISO certification or Quality Assurance Plan. All reference materials will be purchased with Certificates of Analysis. This documentation shall be maintained in each lab area in which the reference material will be used.

5.3.2 Placing Orders

The purchasing of routine supplies necessary for the completion and accuracy of any given test procedure are initiated by the analysts, as needed. Any non-routine laboratory materials/supplies selected by the analysts should be reviewed and approved by the Laboratory Manager(s), Technical Director, prior to purchase. All purchasing is initiated by completion of the Purchase Order Form. Vendor's name, Item(s) reference number, description of the item, quantity requested, date required, and the accounting category, will be filled out by the individual requesting the supplies. The Purchase Order Form is then delivered to the Procurement Coordinator, where a unique purchase order reference number is assigned to each order. It will be the responsibility of the Procurement Coordinator to purchase such supplies from the acceptable list of vendors, as described in Section 5.3.1. No other vendors shall be used in the purchase of laboratory materials/supplies, without specific approval of the Quality Department.

All orders must be signed by the requestor and approved by the supervisor prior to submission to the Procurement Coordinator. Orders received after noon may not be ordered until the next business day due to vendor order acceptance timeframes. Custom standards may require a 4-6 week lead time to be shipped. Any orders over $2500.00 require Corporate approval. Submit a copy of the vendor's quote to the Procurement Coordinator, who will submit it to the AGM/GM and the Administrative Business Manager for submission to Corporate for approval.

After the order is placed by the Procurement Coordinator, the Purchase Order Form is submitted to the Administrative Business Manager for filing.

5.3.3 Receipt of Materials

Supplies or materials are received by the Sample Receiving Client Technician, who in turn, calls the Procurement Coordinator. The Procurement Coordinator compares the materials received to the packing list. Any discrepancies are noted on the packing list and a call is placed by the Procurement Coordinator to the vendor to resolve any issues. If there are no issues and the order is complete as ordered, the Procurement Coordinator submits the packing slip to the Administrative Business Manager. The packing slip is then attached to the corresponding Purchase Order Form and kept on file by the Administrative Business Manager

The materials and associated documentation (i.e. Certificates of Analysis or Purity) are picked up by the Department that placed the order.

All Safety Data Sheets are kept in the lab area where the supplies are being used.

Review Date: October 28, 2015

Figure 5-1
PAES Instrument and Equipment List

Natural Attenuation

EDONORS

Dionex Ion Chromatograph Model ISC 2000 with Degasser (Serial 08120332); Gradient Eluent Generator; AS-AP Autosampler (Serial 14092562), Columns.

Dionex Ion Chromatograph Model ISC 2100 with Degasser (Serial 14092120); Gradient Eluent Generator; AS-AP Autosampler (Serial 14092562), Columns.

Varian 3400 Gas Chromatograph (Serial 10272) with Varian 8100 Autosampler (Serial 1371)

Thermo-Fisher Scientific Ultra Trace GC (Serial 620120045) with TriPlus RSH Liquid Autosampler (Serial 241284)

Risk Analysis

Agilent 6890 Gas Chromatograph (Serial US10347026) with Agilent G1888 Headspace Autosampler (serial IT40220036).

Hewlett Packard 5890 Series A Gas Chromatograph (Serial 2536A05842) with Tekmar 7000 Autosampler (Serial 91099014/91135007)

Hewlett Packard 5890 Series II (Serial 3336A51836) with Tekmar 7000/7050 Autosampler (Serial 91346008/91346016)

Thermo-Fisher Scientific Ultra Trace GC (Serial 620120028) with TriPlus RSH Headspace Autosampler (Serial 237682)

Three Proprietary GCs

GOW MAC Series 580 Gas Chromatograph (Serial 580-200)

Ohaus Discovery Analytical Balance Model # DV215CD (Serial 1128122704)

Wet Chemistry/EACCEPTORS

Dionex ISC 3000 Ion Chromatograph with dual Autosamplers, columns, and ovens with conductivity and UV-VIS detectors

OI Analytical Aurora 1030 TOC Analyzer (Serial J025730751) with Autosampler (Serial E019788198)

Denver Instruments Model SI-4002 Top Loading Balance

Spectronic 20G Colorimeter

Spectronic 20D Colorimeter

Orion 601A pH Meter

Sartorius Model 1612 Analytical Balance

CSIA

Tekmar Aqua Tek 70 Autosampler (Serial US 06151001)

Tekmar Velocity XPT Purge and Trap (Serial US 06191003)

Entech 7100A Pre-concentrator (Serial 1304)

Thermo Trace GC Ultra Gas Chromatograph (Serial 200510408)

Thermo GC-Combustion III Interface (Serial 111201-175)

Thermo GC /TC Reactor OD (Serial 108520-349)

Thermo Delta V Plus Isotope Ratio Mass Spectrometer (Serial 8018)

Thermo-Electron GC (Serial 10603008) with DSQ II Mass Spectrometer (Serial 100442); Varian Archon Autosampler (Serial 14655) and Tekmar Velocity Concentrator (Serial US6047001)

Thermo Delta V Plus isotope ration mass spectrometer

Thermo Conflo IV interface

Thermo GC Isolink interface

Agilent 7890A GC System

Tekmar Aquatek 100 autosampler

Tekmar Stratum Purge and Trap concentrator

Entech 5400 Thermal Transfer System

Entech SL2 Perconcentrator

Agilent 6890N GC (Serial US10226064)

Agilent 5973N MSD (Serial US63810430)

Teledyne Tekmar Aquatek100 Autosampler (Serial US11348004) and Stratum Concentrator (Serial US11327002)

GC/MS Chemstation Datasystem (SN 2UA71516GF)

Agilent 6890N GC (serial # US10232118)

Agilent 7890A GC (serial # CN12121090)

Agilent 5975C MSD (serial # US12157802)

Agilent G4513A autosampler (serial # CN12090144)

Isoprime – GC interface (serial # 10/007)

Isoprime IRMS reference box (serial # 10/008)

Isoprime IRMS (serial # JB166)

EuroVector Elemental Analyzer (serial # 8429)

UPS (Model # TX90-10K)

UPS (Model # T90-EBP920)

Pacific Air Jun-Air Compressor Model 6 (serial # 1010200822)

Supelco 29541-U High Capacity Gas Purifier (serial # 1312955/1A-22)

Fisher Scientific Ultrasonic cleaner (serial # RUA030263007)

Eppendorf Centrifuge 5810R (serial # 581101849)

New Brunswick Scientific Innova 2000 Platform shaker (serial # 300544191)

Pelton & Crane Sterilizer (serial # AF - 005387)

Zymark TurboVap LV evaporator (serial # 04384)

Petroleum Forensics

HP Agilent 7890A GC/5975 MS System (Serial # CN12091092)

HP Agilent 6890 GC/5973 MS System (Serial # US00008852)

HP Agilent 6890 GC/5973 MS System (Serial # US00006875)

HP Agilent 6890N GC System (Serial # US10347026)

HP Agilent 6890 GC System (Serial # US00001417)

HP Agilent 5890 GC System

HP Agilent 5890 GC/5971 MS System

Tekmar LCS 2000 Purge and Trap

ESI Autosampler

Polyscience Refrigerated Recirculator

Zymark TurboVap 500 Concentrator

Sargent-Welch SWT-603D Scale (Serial # T0121781)

Molecular Diagnostics

Nuare Biosafety Cabinet (Serial # 140024091310)

MPBio FastPrep-24 Shaker (Serial # 15040480)

Eppendorf 5427 Centrifuge (Serial # 5427DP621099)

FOTODYNE 1-1430 UV Instrument (Serial # FRG1-0615-1173)

Fisher Scientific FB300 Power Supply (Serial # C1596150102560)

Roche LightCycler 480II/96 QPCR Instrument (Serial # 29818)

HP rp5700 Computer (serial # CZC1164K0C)

Thermo NanoDrop 2000/2000c Spectrophotometer (Serial # R108)

Akonni DX2100 Microarray Imager (Serial # 3968)

Akonni Thinkpad T420 Computer (Serial # 3744)

Akonni Q-Cycler96 DNA Analysis (Serial # 3934)

Esco SCR-2A2 PCR Cabinet (Serial # 2013-84203)

VWR ULT-86 Upright Freezer (Serial # 833020-697)

Heraeus Incubator (Serial # 26286080)

6.0 Data Quality

6.1 Data Quality Objectives

PAES conducts analysis on environmental samples for clients who rely on the data in order to make decisions concerning environmental problems, environmental monitoring, and in many cases to investigate the feasibility of cutting edge remedial technologies. The necessity of high quality data is essential so that the best decisions can be made in the interest of both the environment and the client. PAES believes data quality objectives are applied to a project from the initial sampling to the final data validation process. On a laboratory scale, PAES' data quality objectives are reflected in individual Technical Standard Operating Procedures as quality control acceptance criteria.

Quality control sample acceptance criteria is generated using one of following three methods:

- A minimum of twenty data points are manually collected and entered into an EXCEL spreadsheet. The average percent recovery and/or relative percent difference (RPD) is calculated, whichever is applicable. Acceptance criteria are generated using the standard deviation of the average percent recovery and RPD. Three standard deviations comprise the acceptance range around the average percent recovery and above the RPD.
- Calculated electronically by the LIMS database and expressed in the Control Chart Program.
- Taken from EPA method-specific recommendations in the absence of laboratory-generated criteria.

Acceptance criteria generated from the implementation of control charts, either manually or LIMS generated are evaluated annually or more often. If it is determined that the acceptance criteria has changed to a broader set of limits, the reason for the change is evaluated for error to ensure the analytical method is still in control. When warranted, corrective action shall be instituted by the Quality Systems office or the Operations Department.

All analytical data including quality control results are checked in accordance with the Standard Operating Procedure for Data Integrity, Review and Validation. Performance Evaluation studies are conducted twice a year and the results are reviewed by management. All failed PE samples are followed up with Corrective Actions.

To maintain the quality of laboratory data and to ensure that laboratory procedures are under control, a variety of internal batch quality control samples are analyzed. The data from those samples are used to calculate statistics that help determine precision, accuracy, and to track potential bias. In addition, performance evaluation studies are conducted regularly as well as random submission of blind quality control samples. Certified reference standards are used, as well, to ensure that quality is maintained.

6.2 Internal Batch Quality Control

Batch quality control sample types and frequencies are recommended in published methods and specified in PAES Technical Standard Operating Procedures. In general, a batch of samples consists of twenty samples or fewer (as recommended by analytical methods) that are analyzed at the same time. Typically, a set of internal quality control samples is analyzed once for each batch of clients' samples. The types of internal batch quality control samples are discussed below.

6.2.1 Initial and Continuing Calibration Verification Standards

Initial and continuing calibration standards verify the ratio of instrument response to the analyte amount. Typically, initial calibration verification and continuing calibration standards are made from stock solutions, which are different from the stock used to prepare the initial calibration standards.

6.2.2 Calibration Blank

A calibration blank is a 'clean' sample made from an appropriate matrix and/or solvent. The calibration blank is analyzed to insure that there is no contamination in any part of the analytical system, or to establish a baseline if that "contamination" is expected and known to be of consistent concentration. Calibration blanks are analyzed after each initial, continuing, and calibration verification standard. The analytical result of the blank must be below the laboratory's quantitation limit or project specific requirements in order for analysis to proceed. If the result of the analysis is above the acceptance limit, the source of contamination must be identified and eliminated. The one exception involves the presence of common laboratory solvents as defined by the EPA.

6.2.3 Method (Preparation) Blanks

Method blanks are reagent water or, for solid/waste matrices, sand, or other appropriate material, or an appropriate solvent carried through the entire analytical process to monitor potential contamination that may or may not be introduced during sample preparation and processing. For organic analyses, surrogates and internal standards are added to the method blank.

Method blanks are analyzed at the beginning of the batch and prior to sample analysis. If the analytes of interest are below the laboratory's quantitation limit or project specific limit, sample analysis can proceed. If analyte concentrations are found above the acceptance limits, the source of the contamination must be identified and corrected. The reagents used for sample preparation must be checked for contamination and the samples associated with the method blank must be prepared again and reanalyzed if necessary.

6.2.4 Duplicates

Duplicates are analyzed to assess precision of the analytical procedure. Samples for batch duplicate analyses are selected at random, ensuring that the selection is rotated among client samples so that various matrix problems may be noted and/or addressed. If the sample requires

that an aliquot be removed and placed in another container in order to conduct the duplicate analysis, a representative aliquot is collected using one of the following options discussed below in Subsection 6.3.4.

Precision of the analyses may vary due to the matrix effects of the sample. If the precision is outside established control limits, the duplicate analysis is repeated. If the precision is still outside established control limits and all other quality control checks are within control, a matrix effect is assumed.

6.2.5 Matrix Spike/Matrix Spike Duplicates

Matrix spike and spike duplicate samples are analyzed to determine the extent of matrix bias or matrix interference on analyte recovery and to determine sample-to-sample precision. Analytes stipulated by the method, by regulations, or by other requirements must be spiked into the sample. If not supplied by the client, the analyst may choose these samples at random. Percent recoveries are calculated for each of the analytes detected. The relative percent difference between the samples is calculated and used to assess analytical precision.

Recovery data is highly dependent upon matrix effects. If acceptable recoveries are observed, it is determined that matrix is having no significant affect on the analytical procedure and that sample preparation and analysis have been performed correctly. Whenever precision, calibration, and system quality control checks are acceptable, large or small matrix spike recoveries are attributed to matrix effects. Because samples are spiked prior to analysis, the concentration of the analyte of interest in the sample may be so high that the spike amount is insignificant. In these cases, spike recovery is meaningless and is not calculated.

6.2.6 Laboratory Control Samples

Laboratory control samples are samples that are spiked with a specific concentration of known reference materials, independent of the calibration standards that are carried through the entire analytical process. These standards are used to assess the accuracy of the analytical process. Where possible, acceptance limits are statistically based upon actual laboratory data. If results are outside acceptance limits, corrective action must be performed before sample analyses can proceed.

6.2.7 Surrogate Standards

Surrogates are organic compounds which are similar to analytes of interest in chemical composition, extraction, and chromatography, but which are not normally found in environmental samples. These compounds are spiked into all blanks, standards, samples and spiked samples prior to organic analysis.

If surrogate recovery is not within acceptance limits, corrective action is instituted and reanalysis of those samples occurs.

6.2.8 Insufficient Sample Volume

When there is insufficient client sample volume in a batch to conduct quality control samples for precision, then a laboratory control sample and laboratory control sample duplicate are analyzed.

6.3 Measurements of Data Quality

Data quality measurements vary from parameter to parameter, are represented as warning and control limits, and are displayed along with associated data on control charts. The following types of measurements are utilized by PAES to insure the highest quality data is being provided.

6.3.1 Precision

Precision is a measure of the degree of mutual agreement among individual measurements made under prescribed conditions. Precision of laboratory data is determined through duplicate analyses of samples or matrix spikes and spike duplicates, and is calculated for PAES purposes, as either the range or relative percent difference (RPD) of the measurements.

6.3.1.1 Range

Range is defined as the difference between the highest and the lowest value reported for a sample. Range is used in the laboratory as recommended in published regulatory methods. The formula for calculating range is as follows:

$$Range = HighestValue - LowestValue$$

6.3.1.2 Relative Percent Difference

Relative percent difference (RPD) is used for all of the analytical methods at the laboratory where sample duplicates are analyzed and where both matrix spikes and matrix spike duplicates are analyzed. If one or both measurements are less than the reporting limit, precision is not calculated. The formula for calculating relative percent difference is as follows:

$$RPD = \frac{|A - B|}{\frac{A + B}{2}} \times 100\%$$

6.3.2 Accuracy

Accuracy is the measurement of agreement between a measurement and the true value. It is calculated as the percent recovery of standards and spikes. Accuracy is calculated as the percent recovery of laboratory control samples, matrix spikes, and in organic chemistry surrogate recoveries.

6.3.2.1 Percent Recovery

Percent recovery is used for all of the analytical methods at the laboratory where laboratory control samples, matrix spikes, and/or surrogates are analyzed. The formula for calculating percent recovery is as follows:

$$\%\,\mathrm{Recovery} = \frac{Measurement}{TrueValue} \times 100\%$$

6.3.3 Bias

Bias is defined as a systematic error due to the experimental method that causes the measured values to deviate from the true value. Bias is determined by plotting the average percent recovery and the average relative percent difference on a control chart. A bias is suspected when seven successive data points are plotted on the same side of the average. This is considered an out of control event.

6.3.4 Representativeness

Representativeness is defined as data that accurately and precisely reflect the sampling points or environmental conditions. Numerous items throughout sampling and sample handling must be controlled to maximize representativeness. These include sample collection, preservation, and holding times. Since PAES does not perform sample collection, PAES cannot accept responsibility for representativeness of sample collection.

When an aliquot must be removed from the sample container for analysis or for making batch quality control samples, one of the following two options are used in order to obtain a representative aliquot:

1) If the analysis won't be compromised by agitation, then the sample is stirred, mixed, crushed, blended, as needed, and the aliquot is removed from sample container and placed in another container.

2) If the analysis may be compromised by shaking or mixing the sample, then portions of the aliquot are taken from different places within the original sample container ensuring that the aliquot is as representative as possible of the original sample.

In some cases where a sample cannot be homogenized, the client will be contacted and a course of action will be decided upon according to a mutually agreed upon decision.

6.3.5 Comparability

Comparability is the confidence level with which one set of data can be compared to a related set of data. PAES uses EPA recommended methodology, whenever feasible, participates in internal and external performance evaluation programs, and uses standard reference materials for sample analysis as means of enhancing comparability.

6.4 Validation of Methods

Validation is the confirmation by examination and the provision of objective evidence that the particular requirements for a specific intended use are fulfilled.

PAES validates non standard and laboratory-designed/developed methods, standard methods used outside their intended scope, and amplifications and modifications of standard methods to confirm that the methods are fit for the intended use. The laboratory keep records of results obtained, the procedures used, and a statement that the method is fit for the intended use.

As requests come in they are reviewed to see if they can be satisfied by the standard methods or by our own internally developed nonstandard methods. If the answer is no, a brief search is done for appropriate laboratories and the Technical Director reviews the results to see if a.) any laboratories that have been found can properly fill the clients request, b.) if there is justification for PAES to develop and market an analysis that can fulfill the request. When an analysis is developed, a calibration must be completed along with preparation of an SOP, complete training including an IDOP and a full MDL study. All of these are documented and the records are retained.

6.5 Uncertainty

There are so many sources of uncertainty in a concentration measurement. Certainly, the collection of the sample is a very large source of uncertainty. The particular technique of collection is another, and the location of the points chosen for sampling is a third. Of course, there is uncertainty in analytical measurements as well, and all laboratory analytical procedures are specifically designed to minimize or otherwise control that uncertainty. As such, analytical uncertainty is very likely a minor contribution to the overall uncertainty of any measurement. However, analytical uncertainty is important. There are many potential causes. Some of the most common are enumerated below, along with a brief discussion on how PAES minimizes the effect of each:

- Human factors- by maintaining SOPs which are analysis-not analyst-dependant, and by engaging in training and yearly CDOP's, PAES tries to minimize the analyst-to-analyst variable.
- Accommodations and environmental conditions-Perhaps the biggest variable here is ambient temperature. In our wet chemistry, and one of our non-traditional laboratories, there is manually controlled heating and cooling. In one of our non-traditional analyses rooms there is additional, automated cooling. Since volatiles

are extremely temperature sensitive, both our volatiles analysis laboratory and our CSIA laboratory are furnished with large capacity air conditioning systems.

- Environmental test calibration and method validation-The vast majority of our analytical activities are specifically designed to address these issues. Specifically, it should be pointed out that all of our tests are calibrated with externally certified standards, and then double-checked with a "second source" standard when possible. Additionally, since we utilize many of our own analytical tests, we have strong emphasis on method validation. For a method to be validated here, it must either pass a successful calibration and then be verified against an external source. The method must be successfully brought through an IDOP and then regularly produce valid matrix spike, matrix spike duplicate and sample duplicate analyses, if applicable.
- Equipment-Before a new piece of equipment is routinely used, an IDOP must be successfully completed using that equipment. This minimizes the potential for un-controlled equipment fluctuations.
- Measurement traceability-If an analytical system is internally calibrated, we maintain records of that calibration, including the certificate of analysis of the standards used in that calibration. If the system was externally calibrated, the records of that external calibration are also supplied.

Finally, to measure the total analytical uncertainty we routinely perform LCS's. (LCS's are chosen because they are submitted to the entire analytical procedure.) The typical acceptance range for an LCS recovery is 80-120%, but the LCS performed with a batch and the SOP for the particular measurement technique should be consulted for specifics.

Review Date: October 29, 2015

7.0 Data Handling

PAES maintains records that enable the re-creation of the specific conditions under which data are produced, and method specific Standard Operating Procedures outline procedures for data collection, reduction, validation, and reporting. This section discusses, in general, PAES data handling procedures.

On occasion when a client requests analyses that PAES is not equipped to perform, capacity issues prevent the laboratory from meeting requested turnarounds, or in the event of an instrument failure, a subcontract laboratory may be used. A list of routinely utilized subcontract laboratories is presented in Exhibit 1 at the end of this section. There may be times when an emergency situation occurs or a client may request the use of a subcontractor not currently listed on Exhibit 1. When those situations occur, the name of the subcontractor will be added during the next annual review for all recurring projects.

For cases when the client requests analyses that PAES is unable to perform, the Project Manager notifies the Laboratory Manager of the need to locate a subcontract lab. The Project Manager is responsible for contacting potential subcontract laboratories to determine where the samples will be sent. For routinely requested analyses, standard agreements are in place with the subcontractor. Whenever applicable, subcontract laboratories will be NELAC-approved. Other factors that affect the decision include turnaround, cost, and ability to provide the required data deliverables. Once the decision is made, the Project Manager notifies the client. For cases when the internal problems require the use of a subcontractor, the Laboratory Manager will notify the Project Managers of the situation, what samples are affected, and the proposed resolution. The Project Managers will then contact each affected client to obtain approval prior to samples being shipped to the subcontractor.

All samples that require subcontracted analyses are prepared for shipment by the Project Manager. A chain of custody is prepared detailing the sample identification, collection date and time, as available, requested analyses, requested due date, and any other special instructions pertinent to the sample shipment. The samples are packed in a cooler with sufficient ice to maintain the appropriate temperature during shipment. All samples for subcontracted analyses are shipped so that the samples arrive the next business day.

All data received from the subcontract laboratory follow the same guidelines detailed in this section, with the Laboratory Manager filling the analyst's role and review performed by the NA Laboratory Manager.

7.1 Data Collection

All laboratory employees are responsible for maintaining laboratory records and documenting them in sufficient detail to recreate analyses. Manually entered data are made using permanent ink. Corrections are indicated by drawing a single line through the incorrect entry, dating and initialing the correction, and coding the reason for the correction. The use of correction fluid or tape, erasure, or other means of making corrections is prohibited. The following information is

recorded at the bench either manually or printed out via the data system interfaced with the analytical instrument.

- Method performed.
- Analysis date.
- Analysis time.
- Analyst signature or initials on computer printouts.
- Instrument Identification and settings.
- Analytical sequence consisting of a chronological listing of the processing for each standard, quality control check, and sample recorded in an analytical sequence, run log, or data sheet.
- The laboratory sample number.
- Quality control sample type.
- Standard identification and volume used for all calibration standards.
- True value and lot number of all spiked quality control samples.
- Dilutions including actual initial and final volumes.
- Sample aliquot and final volume.
- Instrument reading.
- Final results with units.
- Calculations for all quality control checks.
- Narrative describing any unusual observances.

If an analysis extends over more than one shift or day, each person responsible for part of the analysis records the date and time their portion of the analysis was initiated.

7.2 Data Reduction

Reducing raw data into a presentable form is the responsibility of the analyst performing the determination. The actual equations used to calculate final results are found in the analytical methods. The following general rounding rules are used for the calculations:

- Data is not rounded until the final answer is obtained.
- To round a figure, the number of significant figures is determined. If the figure to the right of the immediate right-most significant figure is greater than 5, round up. If this figure is less than 5, truncate the result after the last reportable figure. If this figure is equal to 5 and there are non-zero digits to the right, round up. If the figure is equal to 5 and there are no non-zero digits to the right, round up when the preceding figure is odd, and truncate when the preceding figure is even.

7.3 Data Validation

Each analyst initials and dates the data that is generated in the laboratory. All data generated by the laboratory undergoes either an independent peer review or other designated individual to ensure compliance with accepted quality control standards prior to data entry. The purpose of this

review is to check for precision, accuracy, and completeness. The following items are verified during this review. Not all items are applicable to each test.

- Holding times.
- Proper measurement units.
- Instrument tune and initial calibration criteria.
- Proper number of calibration standards and blanks.
- Surrogate and spike percent recoveries.
- Comparison of quality control sample results to acceptance criteria.
- Corrective action for out of control conditions.

After this review, all data that is not instrument-interfaced directly with the Laboratory Information Management System (LIMS), is manually entered into the database. All manually entered data undergoes a review upon entry. The Laboratory Manager attempts to review approximately 10% of all laboratory data. Either the Quality Systems Manager or his designee will review 10% of all DoD data packages. This review is part of the oversight program and does not have to be completed in "real time." Project Managers complete the data validation process by reviewing final reports for completeness prior to submission to the client.

7.4 Laboratory Information Management System/HORIZON

The laboratory currently operates and maintains a Horizon LIMS system. This system is the point of collection for all of the laboratory data. The integrity of laboratory data is of the utmost importance. This system has built-in security levels that keep individual access on an "as needed" basis and does not allow for access beyond what is necessary for the completion of individual duties. Specific operation and management of the LIMS system is outlined in the LIMS Standard Operating Procedure that is maintained by the Laboratory.

7.5 Report Preparation

7.5.1 Horizon LIMS

After all of the data has been entered into the LIMS, a draft copy of the final report is generated and the following items are reviewed by the Laboratory Manager or their designee:

- Client name and address.
- Analytical results, units, and reportable figures.
- Appropriate data qualifiers are applied as required according to the following table.
- Inter-parametric relationships.
- Data reasonableness in respect to sample information.

Data Qualifiers
HORIZON LIMS

Qualifier	Description
J	Estimated value-result is >MDL but <PQL
U	Component was analyzed for but not detected
G*	Analyses were performed by subcontract lab

* each available sub-lab has a specific designation, this qualifier will vary between individual laboratories.

Following the review, if results are acceptable the Laboratory Manager, or designee makes the determination to generate a final report. The final report is electronically stamped with the assigned Project Manager's signature and printed. The report is forwarded to the Project Manager who conducts a general review for completeness and releases it to the client. The draft copy and signed final copy are electronically stored for future reference.

7.6 Final Report Modifications

Once a laboratory final report is generated and sent to the client, it can be modified under the following circumstances, depending on which LIMS processed the clients project:

- An electronic or hard copy of the original unedited report is kept on file in the laboratory. In the case of electronic records and/or files, either a pdf is generated of the original report prior to the editing, or a paper copy of the original report is placed in the project file.
- The reissued report must have a statement in the comments section that specifies the modification(s) and indicates the date of report reissue.
- An electronic or hard copy of the reissued report is retained for future reference and stored with the original report.

Data review of report modifications is conducted in accordance with PAES Standard Operating Procedure for Data Review and Validation.

7.7 Record Retention

A signature record of all employees is maintained in the Training Records Manual kept in the Quality Systems Office.

All raw data and reports for analytical projects are kept for a full five (5) years. After this time the records are destroyed. A Record Release Checklist is posted in the storage area. A destruction date

will be recorded on that form when a particular years' records are destroyed. Records are kept onsite in a locked storage area and maintained in accordance with PAES Standard Operating Procedure for Document Control. The area is inspected monthly.

The LIMS database, which retains all electronic records that have been entered from the date of the LIMS inception, is backed up each day. The tape on which this backup is stored is maintained in a secure location off-site.

All critical data on personal computers is backed up on the internal network S drive. The network is backed up on tape and stored at a secure location off-site.

7.8 Service to the Client and Confidentiality

Clients are welcome to an on-site visit to PAES Laboratories in order to discuss client needs or requests, and also to monitor the laboratory's performance in relation to ongoing client projects. All efforts are made to maintain client confidentiality while providing service to other clients.

All client data, whether from privately owned or government organizations, and all correspondence is considered confidential information and shall not be released to anyone other than the client without the expressed written permission of the client. These transactions shall be handled by the Customer Service Office.

7.9 Records Dispensation

In the unlikely event that the laboratory records are lost or being destroyed, either because the laboratory transfers ownership or goes out of business, all clients will be notified in writing and requested to notify PAES concerning the dispensation of their records.

Exhibit 1

Subcontractor Laboratories

Name	Requested Analyses
Pace Analytical Services Greensburg, PA	Semivolatile organics, Pesticides, PCB's, Herbicides, Volatiles by 8260 and 624, EDB by 8011,Gasoline and Diesel Range Organics, Wet Chemistry Parameters, Metals.
Pace Analytical Services Indianapolis, IN	8021 volatiles
Pace Analytical Services Minneapolis, MN	TO-14 Suma canisters
Alternative Testing Laboratory Latrobe, PA	Silicon, Percent Chloride on Ash, Total Carbon, Sulfur
Pace Analytical Services Seattle, Washington location	All analyses for DoD projects
Test America Nashville, TN	Formaldehyde

Name	Requested Analyses
Test America Pittsburgh, PA	Anions (9056), TOC Walkley Black, Lloyd Kahn
Geochemical Testing Somerset, PA	NEPO
University of OK	CSIA-Hydrogen, CSIA-Chlorine, CSIA-Chlorinated (soil gas-Vapor)
Northern Arizona University Flagstaff, AZ	$\delta D + \delta^{18}O$ analysis
University of Pittsburgh Pittsburgh, PA	Nitrate/Ammonia Isotopes ($\delta^{15}N + \delta^{18}O$)
Tetra Tech Fort Collins, CO	Boron isotope analysis
Syracuse University Syracuse, NY	$^{87}Sr/^{86}Sr$ analysis
Isotech Champaign, IL	Tritium, and C-14 age dating

Name	Requested Analyses
Environmental Analytical Service San Luis Obispo, CA	Gas composition C2-C10
Clark Laboratories Jefferson Hills, PA	Viscosity
Molecular Research Shallowater, TX	DNA amplification

8.0 Measurement Traceability

Traceability of measurements and standards is ensured in the laboratory by using balance calibration weights that are traceable to national standards, calibrating thermometers using an NIST calibrated thermometer, and by the use of certified standard solutions.

8.1 Reagents and Standards

The purity of the materials required in analytical chemistry varies with the type of analysis, the parameter being measured, and the sensitivity of the detection system. In general analytical reagent grade is satisfactory for most inorganic analyses. Other analyses, such as trace organic, may require special ultra-pure reagents. In cases were the method does not specify the purity of the reagent, it is intended that analytical reagent grade be used. The labels on the container are checked and the contents examined to verify that the purity of the reagents meets the needs of the particular method involved.

8.1.1 Reagent and Standard Preparation

Reagents are prepared and standardized with the utmost of care against reliable primary standards. They are re-standardized or prepared fresh as often as required by their stability as specified by method and other reference sources. Stock and working standard solutions are checked regularly for signs of deterioration.

Standard preparation procedures are specific to the analytical determination being made and are defined in detail in specific technical Standard Operating Procedures, regulatory methods, and in the laboratory's Standards Logbooks.

8.1.2 Reagent and Standard Labeling and Storage

Standard solutions are labeled with the compound name, lot number, preparation date, and expiration date. The analysts store reagents and solvents in a manner that prevents contamination and deterioration prior to their use. Standard solutions are stored in compatible containers.

PAES Standard Operating Procedure for Analytical Standards and Reference Materials (SOP-ADM 15) gives detailed instructions for handling, storing, labeling, and documenting standards and reference materials.

8.1.3 Standards Preparation Logbook

Standard Preparation Logbooks are issued as controlled documents to every analyst or laboratory in which they will be used. These logbooks are used to document standard preparation procedures, dates, lot numbers, concentrations, manufacturer, expiration date, and any other information that may be necessary in order to re-create or track a particular standard. The compound or element name and/or formula are documented along with the final concentration or normality. The

description of how reagents and standards are prepared may be referenced from a previous description if the exact procedure is used.

8.1.4 Traceability of Standards

The traceability of each purchased stock standard is easily accessible. Certificates of analysis of each standard are maintained in a binder in the laboratory until the standard is depleted or disposed. The certificate is then given to the quality manager for archiving. The traceability of each laboratory prepared standard is entered into standard logbooks.

For DoD projects: All bottles, reagents, solvents, and supplies used in DoD projects will be verified or certified by the supplier to meet or exceed standard specifications for environmental tests concerned. Verification must be kept on file to qualify each bottle, reagent, solvent and supply.

8.2 Thermometers

All of the laboratory thermometers in use are calibrated annually using a thermometer that is traceable to NIST. Thermometer calibration is outlined in PAES Standard Operating Procedure for Calibration of Thermometers.

8.3 Weights and Balances

All balances are calibrated before use with Class I NIST traceable weights that are calibrated annually. Balances are serviced and calibrated by an outside contractor annually. Additional information is outlined in PAES Standard Operating Procedures for Calibration of Weights and Balances.

9.0 Training Program

Training for laboratory personnel is accomplished at several levels. Areas for which training is conducted include new employee orientation, laboratory safety, specific task training, analytical procedure training, laboratory ethics, and other technical training courses as the need arises.

Analytical training, while addressed in general in this manual, is addressed specifically in the Standard Operating Procedure for Administering and Documenting Training in Laboratory Procedures and Instrumentation.

9.1 New Employee Orientation

Orientation is conducted to familiarize new employees with company policies, quality system procedures, facilities, coworkers, laboratory ethics, and laboratory safety. The Department Managers are responsible for notifying the various departments of the start date of all new employees.

9.2 Laboratory Safety

Upon hire, each employee is required to read the laboratory's Chemical Hygiene Plan (safety manual), is issued a pair of safety glasses, and is instructed in basic laboratory safety requirements. Documentation of safety training is updated and maintained by PAES' Safety Officer.

9.3 Task Training

Task training must be successfully completed for employees to perform the following tasks without direct supervision:

- Sample Receiving
- Bottle Preparation
- Customer Service
- Data Entry

Task training is conducted by the Department Manager of the department concerned. During this training, the trainer works closely with the trainee to ensure that all pertinent points of procedures are addressed. If the procedure is outlined in a Standard Operating Procedure (SOP), the trainee is charged with reading the SOP and the trainer will ensure that the training covers all aspects of the SOP. For training to be considered complete, proficiency in the task must be demonstrated to the trainer.

9.4 Analytical Method Training

Prior to conducting analysis on client samples, all analysts must demonstrate their proficiency through initial technical training. Analytical proficiency must be demonstrated annually thereafter.

All analytical method training must be conducted by an analyst who is certified in the method for which training is required.

For individual analyst training in sample preparation and analysis, initial training and proficiency is demonstrated through the analysis of a set of 4 consecutively run mid-range standards or an Initial Demonstration of Proficiency (IDOP). When an analysis involves a work group (i.e. semivolatile preparation and analysis), a team approach to the IDOP applies. When each individual completes their part in the successful analysis of the IDOP, the analytical team is considered competent to conduct the analysis on client samples.

For continued demonstrations of capability for individuals and work groups, one of the following procedures may be used:

1) Another IDOP
2) Four consecutively run laboratory control samples that fall within laboratory/method acceptance criteria.
3) Acceptable analysis of Performance Evaluation samples.
4) Acceptable analysis of blind quality control sample.

Training documentation is maintained in the Quality Department office. See Exhibit 9-1 for a flow diagram of analytical method training. A Demonstration of Capability Certification Statement (Exhibit 9-2) shall be maintained for each method in which an employee is certified. This documentation is kept in the Employee Training Records in the Quality Department office. PAES is also utilizing the Pace Corporate LMS on-line training system to track IDOP's and as a means to access all Pace Corporate documents.

9.5 Laboratory Ethics Training

All employees shall receive initial and annual ethics training. The training shall be conducted by PAES' management or designated trained personnel. The training shall include the contents of the Ethics Program in its entirety, including employee and supervisory responsibilities, examples of unethical behavior, disciplinary action for unethical actions, and a means to report unethical actions. The power point presentation of the Ethics Training Program is located on the Pace Corporate LMS on-line training system.

Documentation of Ethics Program Training is kept in the Quality Department office and in the LMS system. All employees are required to sign and date the Ethics and Data Integrity training in the LMS.

9.6 Other Technical Training

Other types of technical training are conducted on an as-needed basis and may include training on new instruments, new procedures, or new equipment. Training may be conducted by PAES' employees

9.7 External Training

Employees are encouraged to continue their education through the use of symposia and seminars conducted by professional societies, regulatory agencies, and equipment manufacturers. These courses serve as one way for laboratory personnel to remain current on regulatory trends, analytical procedures, and advances in instrumentation. Documentation of external training will be added to the analysts' training records and in the LMS.

Review Date: October 29, 2015

Exhibit 9-1

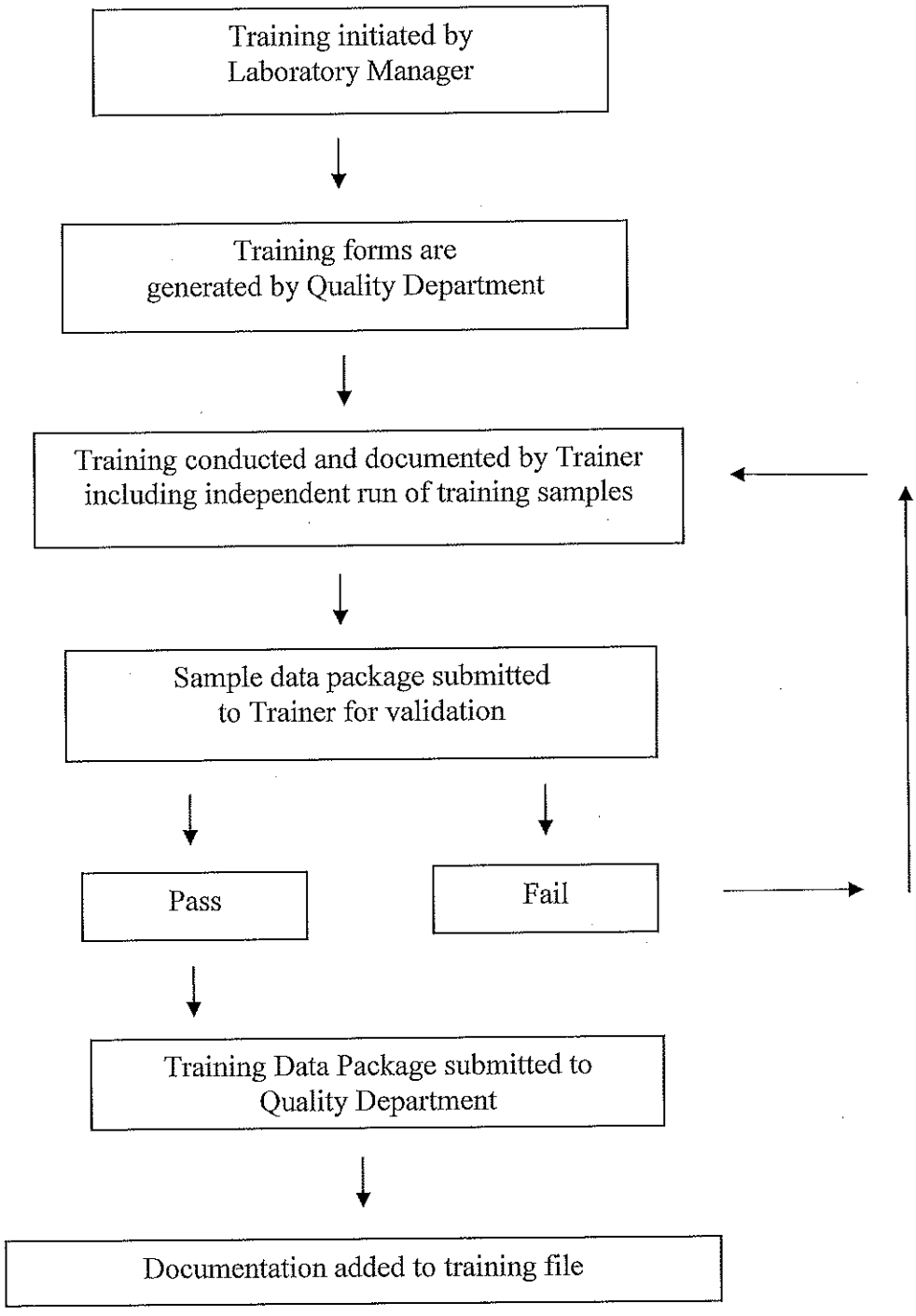
Training initiated by Laboratory Manager
Training forms are generated by Quality Department
Training conducted and documented by Trainer including independent run of training samples
Sample data package submitted to Trainer for validation
Pass
Fail
Training Data Package submitted to Quality Department
Documentation added to training file

Exhibit 9-2

Demonstration of Capability Certification Statement

Date: _____

Pace Analytical Energy Services, LLC
220 William Pitt Way
Pittsburgh, PA 15238

Analyst Name: _____

Matrix: (laboratory pure water, soil, air, matrix spike)

Analyte (or group)	**Method Number**	**SOP #**	**Revision #**

I, the undersigned, CERTIFY that:

1. The analyst(s) identified above, using the cited test method (s), which is in use at this facility for the analyses of samples under the National Environmental Laboratory Accreditation Program, have met the Demonstration of Capability.

2. The test method was performed by the analyst(s) identified on this certification.

3. A copy of the test method and the laboratory-specific SOPs are available for all personnel on-site.

4. The data associated with the demonstration of capability are true, accurate, complete, and self-explanatory.

5. All raw data (including a copy of this certification form) necessary to reconstruct and validate these analyses have been retained at the facility, and that the associated information is well-organized and available for review by authorized assessors.

_____ _____

Charlotte Washlaski
Quality Manager

Date

Administrative Business Manager

General Description: This exempt managerial position is responsible to and reports to the Assistant General Manager to provide ongoing periodic financial reports and business reviews as the business cycle requires and demands.

Educational Requirements: This position requires a Bachelors Degree in Business.

Job Responsibilities:

- Prepare monthly financial statements for review.
- Reconcile bank statements.
- Prepare monthly budget performance reviews.
- Account Receivable tracking and resolution.
- Cash management recommendations and review.
- Payroll processing activities.
- Insurance review.
- Office Management.

Assistant General Manager

General Description: This exempt managerial position is responsible for guiding a team that is charged with the product line performance as a business unit. The team includes departments dealing with dissolved gases, vapor, electron donors, electron acceptors, general chemistry, CSIA, petroleum forensics and molecular diagnostics.

Educational Requirements: This position requires a bachelor's degree in Chemistry or related field and three years+ of product and product instrumentation experience or ten+ years of relevant product and product instrumentation experience.

Job Responsibilities:

- Manage the integration of routine and development of activity within the different department.
- Manage and operate the LIMS System.
- Advise the GM of capital equipment needs.
- Recommend specific capital equipment for purchase or lease.
- Maintain budgetary restraints for profitability.
- Make personnel recommendations to the GM.
- Responsible for laboratory code of conduct and staff disciplinary action.

Department Laboratory Operations Manager

General Description: This exempt managerial position is responsible for overseeing the daily management of the laboratory operations and operations' staff. This position reports to the Assistant General Manager.

Educational Requirements: This position requires a Bachelor's Degree in Chemistry or a related field with a minimum of ten years of experience.

Job Responsibilities:

1. Provide supervision and direction to all department personnel.
2. Manage the size of the department efficiently in accordance with available workload and communicate staffing requirements to the Assistant General Manager.
3. Responsible for scheduling work and laboratory personnel to ensure efficient use of time and resources.
4. Manage routine product generation within the laboratory, including but not limited to scheduling of sample screening and analyses, evaluation of preliminary results, assessment of quality, and preparation of client reports.
5. Responsible for ensuring that the highest degree of technical quality possible is represented in outgoing final analytical data reports.
6. Ensure that laboratory work assignments are coordinated with work assignments of other groups in the company.
7. Work in conjunction with the Technical Director to provide input and support for instrumentation needs.
8. Coordinate with the Quality Systems Manager to develop, review and implement Standard Operating Procedures.
9. Support and enforce the specific methods, policies, and procedures outlined in PAES' Standard Operating Procedures and Quality Systems Manual.
10. Coordinate and ensure MDLs, and PQLs are updated in the LIMS as required.
11. Responsible for the administration of the Chemical Hygiene Plan within the laboratory.

Quality Systems Manager

General Description: This exempt managerial position carries the responsibility for providing leadership and direction to ensure that the laboratory function at the highest level of quality possible in accordance with regulatory and certification requirements.

Educational Requirements: This position requires a Bachelor's degree in chemistry or a related discipline and/or a minimum of five years of laboratory experience.

Job Responsibilities:

1. Provide leadership and direction for the laboratory's Quality Systems Program.
2. Provide supervision and delegate tasks to the Quality Assurance Analyst.
3. Keep current on regulatory requirements to ensure that Standard Operating Procedures for analyses are in compliance with applicable regulations.
4. Conduct laboratory quality audits according to the annual schedule.
5. Serve as liaison between Microseeps and Regulatory Agencies.
6. Provide leadership and direction for developing and maintaining all Laboratory Standard Operating Procedures and the Quality Systems Manual.
7. Work with the Quality Assurance Analyst and the Laboratory Manager to discern and correct issues leading to poor quality and, if deemed necessary stop unsatisfactory work or prevent reporting of unjustifiable results.

Technical Director

General Description: The Technical Director is responsible for directing and managing an ongoing research and development program that insures the laboratory is ready to respond to leading edge technology needs.

Educational Requirements: This position requires a graduate degree in chemistry or a related discipline and a minimum of ten years of laboratory experience.

Job Responsibilities:

1. Provide assistance with interpretation of client data needs and data reports in cooperation with the Customer Service Department.

2. Assist clients in defining data needs, constructing sampling plans and interpreting data reports via non-binding suggestions and selected references to published documents.

3. Prepare and present presentations at seminars, workshops, or conferences.

4. Develop written material for company personnel to provide client assistance and education.

5. Identify emerging analytical needs and develop conceptual models for analytical methods to support those emerging client needs.

6. Develop conceptual analytical methods into routine procedures for lab personnel to implement.

7. Ensure that new method development is fully documented by compiling a complete package of experimental data in a form that is organized, summarized, and that can be validated.

8. When new analytical methods have become routine procedures, transfer responsibility to the Laboratory Manager.

9. Responsible for knowing industry trends and emerging opportunities.

Client Services Manager

General Description: This exempt managerial position is responsible for directing the activities of the Customer Service Staff, Bottle Preparation, and Sample Receiving. This position is ultimately responsible for ensuring customer service satisfaction. This position reports directly to the Assistant General Manager.

Educational Requirements: This position requires 10+ years of environmental laboratory management experience.

Job Responsibilities:

1. Responsible for overall management of the Customer Service Department which includes the traditional customer service functions, bottle preparation, shipping and sample receiving.
2. Responsible for direct involvement with clients in all extraordinary issues such as late reports, missing shipments, inappropriate charges, etc..
3. Responsible to direct all inquiries to the proper department.
4. Responsible for customer care code of conduct and disciplinary action.
5. Knowledgeable of all the functions of a Customer Service Representative.
6. Oversee the review of contracts.
7. Oversee purchasing for Bottle Preparation.
8. Act as liaison with other departments to ensure interdepartmental communication.
9. Ensure customer complaints are resolved to the customer's satisfaction.

Quality Assurance Analyst

General Description: This exempt position is responsible for assisting the Quality Systems Manager to ensure that the Quality Systems Policies and Procedures are implemented in accordance with the Quality Systems Manual and PAES Standard Operating Procedures. This position reports to the Quality Systems Manager.

Educational Requirements: This position requires a Bachelor's Degree and 2 years of laboratory experience.

Job Responsibilities:

1. Administratively responsible for the Quality Systems Program as directed by the Quality Systems Manager.
2. Prepare an annual schedule of laboratory audits.
3. Prepare audit reports and necessary corrective action to the Laboratory Manager.
4. Follow up on all corrective action reports until appropriate action has been taken.
5. Establish a schedule, order supplies, coordinate, and submit final analytical data for performance evaluation studies.
6. Maintain, control, and update the Quality Systems Manual and all of PAES' Standard Operating Procedures.
7. Ensure new Operation's Department employees receive required training and orientation and maintain the documentation of the training.
8. Ensure appropriate studies are conducted when necessary i.e. Initial Demonstrations of Proficiency and MDL's.
9. Ensure that all lab thermometers are calibrated as required.
10. Annually send out scale weights, radiation screening instrument, and NIST thermometer for calibration.
11. Coordinate annual inspections for certifications of balances and fume hoods.

Procurement Coordinator

General Description: This exempt position is responsible for all aspects of purchasing and supply receipt and reconciliation. This position reports to the Administrative Business Manager.

Education Requirements: This position requires a high school diploma and two years of laboratory experience. A basic knowledge of chemistry and laboratory analytical procedures is required.

Job Responsibilities:

1. Purchase, track, receive, and distribute supplies for the laboratory.

Sample Custodian

General Description: This exempt position is responsible for all aspects of sample custody from sample receipt to storage until final disposal. This position reports directly to the Client Services Manager.

Education Requirements: This position requires a high school diploma and two years of laboratory experience. A basic knowledge of chemistry and laboratory analytical procedures is required.

Job Responsibilities:

1. Receive and inspect samples and sample containers and sign appropriate documents according the Standard Operating Procedure for Sample Receiving and the Quality Systems Manual.
2. Record all necessary information on chain of custody.
3. In the event of any discrepancies or non-conformance issues with the above procedures, immediately complete a non-conformance form and submit it to customer service.
4. Notify Customer Service Rep upon receipt of client samples when requested.
5. Accurately log samples into LIMS ensuring that all required fields are completed for the level of analysis required.
6. Label all sample containers.
7. Initiate transfer of samples as soon after receipt as possible to appropriate storage areas, ensuring that all samples are maintained at the appropriate temperature at all times.
8. Notify analysts immediately upon receipt of samples with short holding times.
9. Control and monitors access to and storage of samples in secure storage.

Staff or Laboratory Analyst

General Description: This exempt position is responsible for the timely analysis and custody of client samples. Job responsibilities cover a broad range of duties and responsibilities depending on employee education and experience. This position reports directly to Manager of their department.

Educational Requirements: This position covers a range of educational levels from a high-school education with on-the-job training to a Ph.D. in Chemistry or a related field. Analysts must pass Initial Demonstrations of Proficiency for every analytical method before independent analysis can be conducted.

Physical Requirements: This position requires the ability to lift 20 pounds and the ability to stand for extended periods of time.

Job Responsibilities:

1. In matters concerning order and priority of analysis, this position is accountable to, and will take direction from the Manager of their department.
2. Keep all workspaces neat, clean, and organized.
3. Obtain samples from Sample Receiving.
4. Observe internal chain of custody requirements for all samples taken from Sample Receiving.
5. Ensure all aliquots analyzed are representative of the entire sample.
6. Analyze samples according to Microseeps Standard Operating Procedures (SOP) and or the applicable Standard or EPA Methods.
7. Observe and practice applicable quality control procedures in accordance with the Laboratory Quality Systems Manual and specific SOPs. This includes analyzing required quality control samples, ensuring results are within specified acceptance limits, and initiating corrective action when results are outside of acceptable parameters.
8. Analyze samples arriving with short holding times within the applicable time frame.
9. Review peer analytical data for completeness and accuracy where possible.
10. Responsible for making accurate entries into logbooks.

11. Conduct equipment preventative maintenance according to the Equipment Maintenance SOP.

12. Maintain supply inventory and notify lead analyst when laboratory supplies are needed.

13. Comply with all Health and Safety Procedures outlined in the Chemical Hygiene Plan.

14. Work with the Health and Safety Officer to help correct suspected unsafe practices, situations, or working spaces.

15. Identify any problems with samples, equipment, or procedures that will affect the integrity of analysis and report them to the Manager of their department.

Customer Service Representative

General Description: This exempt position is responsible for marketing, inside sales, and project management. This position reports to the Client Services Manager.

Educational Requirements: This position requires a minimum of five years of customer service experience in the laboratory, environmental, or chemistry field.

Job Responsibilities:

1. Generates quotes.
2. Serves as the liaison between clients and the technical departments.
3. Takes bottle orders from clients.
4. Enter projects into the LIMS.
5. Manage projects as required according to client contracts.
6. Signs final data reports acknowledging that the reports are being sent.
7. Contact clients as required by Non-Conformance Forms.
8. Arrange rush and special analytical projects with Laboratory Manager.
9. Coordinate initial review of contracts.
10. Serve as PAES representative to the client and as such, conduct themselves with the highest standard of ethics, is responsive to clients' needs, and portrays a level of professionalism for which PAES is known.
11. Create, generate, and disseminate company information to clients as requested.
12. Review invoices for accuracy.

LIMS Administrator

General Description: The LIMS Administrator position is responsible for the overall development, testing, maintenance, documentation, and support of all Electronic Data Deliverable (EDD) related processes, code and transactions. The Customer Service Assistant aspect of the position is responsible for specific customer service activities as they relate to the coordination of project work and consistently provides work on a timely basis.

Educational Requirements: This position requires High School education plus an Associate degree in Information Technology. Two years experience working with Electronic Data Interchange processes. Must also possess strong skills with SQL scripting and SQL Stored Procedures, as well as abilities with Microsoft SQL Server, Enterprise Manager, and Query Analyzer.

Job Responsibilities:

1. Provide technical support for all EDD related implementations.
2. Analyze client requirements, specify design, and develop new EDD solutions.
3. Modify and enhance existing EDD related code or procedures.
4. Provide customer support and correct reported problems with EDDs.
5. Utilize and develop procedures for EDD checking utilities, formatting applications and other tools as necessary.
6. Develop and publish documentation and procedures regarding proper uses and operations of the EDD environment as well as individual EDD requirements, structure, code, and results.
7. Perform training for responsible parties on the use of EDD related processes.
8. Work with customers, staff, external IT consultants and managers for both new development and problem determination/resolution.
9. Assure the highest levels of stability, integrity, reliability, performance, security, and availability of EDDs consistent with the resources available and the established change control policies, and prescribed procedures.

10. Use established user request and problem management tool to track requests and follow up to resolution and closure.

11. Perform special projects or other duties as required.

12. Review and check project files when received from login for correctness and completeness.

13. Review and prepare data packages by paginating data, scanning reports, and burning CDs.

14. Prepare and send Excel reports and invoices to clients electronically.

15. Receive and fill out bottle orders for clients when taking client calls.

16. Answering the telephone when required for customer satisfaction.

Bottle Preparation Technician

General Description: This non-exempt position consists of up to forty hours of work per week in completing bottle preparation activities. This position reports to the Client Services Manager.

Educational Requirements: High School Diploma with knowledge in basic chemistry. Computer skills are required, as well as, competencies in basic math, reading, and writing.

Physical Requirements: The position requires a maximum lifting capacity of 40 pounds with the ability to lift and carry large and bulky objects. The job skills also require a full range of motion for bending over and straightening.

Job Responsibilities:

1. Properly assemble, prepare, preserve, package and ship orders following Company Standard Operating Procedures in a cost effective and timely manner.
2. Inventory, order, track, and stock all necessary bottle preparation supplies.
3. Track, maintain, and fill all standing bottle orders for pick-up, delivery, and shipment.
4. Keep accurate records and files of standing orders, supply orders, and inventories.
5. Practice open communication in all instances with the Customer Service department in order to assure clients get the best possible service.
6. Maintain a neat, clean, and organized work and storage area.
7. Wear safety glasses while in bottle preparation room, and other protective clothing such as gloves and smocks when using chemicals, handling samples, and cleaning coolers.
8. Serve as courier for pick-up or delivery when necessary.
9. Clean and dry all coolers that arrive prior to placing them in storage.
10. Obtain stock preservatives.

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