SHENANDOAH ROAD GROUNDWATER CONTAMINATION SUPERFUND SITE
TOWN OF EAST FISHKILL, DUTCHESS COUNTY, NEW YORK

Comprehensive Monitoring Plan

Federal Superfund Identification Number: NYSFN0204269
NYSDEC Site Number: 3-14-104

Revisions to Final Approved Comprehensive Monitoring Plan:

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ABBREVIATIONS / ACRONYMS

AOC	Administrative Order on Consent
AWSRA	Alternate Water Supply Response Action
bgs	below ground surface
cis-1,2-DCE	cis-1,2 dichloroethene
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CMP	comprehensive monitoring plan
COCs	constituents of concern
DNAPL	dense non-aqueous phase liquid
EPA	United States Environmental Protection Agency Region
FDS	Field Data Sheet
FS:	feasibility study
GAC	granular activated carbon
gpm	gallons per minute
GSC	Groundwater Sciences Corporation
GSPC	Groundwater Sciences, P.C.
HDPE	high-density polyethylene
IBM	International Business Machines
IGI	Initial Groundwater Investigation
MNA	monitored natural attenuation
MCL	maximum contaminant level
NTCSRA	Non-Time-Critical Source Removal Action
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
OM&M	Operations, Maintenance and Monitoring
PCE	tetrachloroethene
POET	point of entry treatment
PVC	polyvinyl chloride
QAPP	quality assurance project plan
ROD	record of decision
RD/RA	remedial design / remedial action
RI	remedial investigation
RI/FS	remedial investigation/feasibility study
RSCOs	recommended soil cleanup objectives
SCGs	standards, guidance and criteria
SETS	source extraction and treatment system
SLERA	Screening Level Ecological Risk Assessment

SOW	statement of work
SRST	Shenandoah Road Service Territory
STWD	Shenandoah Town Water District
TAGM	Technical and Administrative Guidance Memorandum
TAL	target analyte list
TCE	trichloroethene
TCL	target compound list
TCLP	toxicity characteristic leaching procedure
ug/L	micrograms per Liter
ug/m^3	micrograms per cubic meter
VC	vinyl chloride
VOCs	volatile organic compounds

1 INTRODUCTION

This comprehensive groundwater, groundwater seep, surface water and sediment monitoring plan (Comprehensive Monitoring Plan or CMP) has been prepared for the Shenandoah Road Groundwater Contamination Superfund Site (Site) located in the Town of East Fishkill, Dutchess County, New York (see Figure 1-1) by Groundwater Sciences Corporation (GSC) at the request of the International Business Machines Corporation (IBM). Figure 1-1 shows the extent of contamination at the Site and the location of the 7 East Hook Cross Road Facility (Facility) at which releases of constituents of concern (COCs) are alleged to have occurred. As such, this CMP satisfies the monitoring requirements detailed in the United States Environmental Protection Agency (EPA) Consent Decree (CD) in accordance with the remedy selected for this Site, i.e., Monitored Natural Attenuation (MNA) for the Groundwater Plume and Source Extraction and Treatment, as documented in the EPA *Record of Decision for the Shenandoah Road Groundwater Contamination Superfund Site* (EPA, September 30, 2012) (ROD).

This CMP provides protocols and specifies methods which will allow for the collection and analysis of representative samples and related field data to assess the performance of the selected remedy for the Site. The CMP includes: the Non-Time-Critical Source Removal Action (NTCSRA) sampling plan associated with the Source Extraction and Treatment System (SETS) previously approved by EPA and implemented by IBM; the remaining groundwater monitoring wells, groundwater seep, and surface water/sediment sampling locations that constitute the MNA Plan; and the shallow Facility groundwater (pit water) pipes that augment the previously approved SETS monitoring plan.

The CMP also includes specific Quality Assurance / Quality Control (QA/QC) requirements for associated groundwater, groundwater seeps, surface water and sediment monitoring activities in the form of an attached Quality Assurance Project Plan (QAPP). Although published as Appendix B to the Remedial Design / Remedial Action Work Plan (RD/RA Work Plan), this CMP is structured as a stand-alone document and may only be revised with the approval of the EPA.

1.1 Background

EPA and the New York State Department of Environmental Conservation (NYSDEC) together with the New York State Department of Health (NYSDOH) began a residential well sampling program in June 2000 in response to the detection of tetrachloroethene (PCE) in homeowner wells in the Shenandoah area of the Town of East Fishkill, Dutchess County, New York (Figure 1-1). These measures were undertaken as a federal removal action under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended (CERCLA). Subsequently, EPA installed Point of Entry Treatment (POET) systems at 57 residences where PCE concentrations exceeded the federal Maximum Contaminant Level (MCL) of 5 ug/L.

In the fall of 2000, EPA determined the probable source of this contamination to be historical operations in a building located at 7 East Hook Cross Road (Facility) as shown on Figure 1-1. EPA began a removal action for contaminated soil which continued through May 2001. The Site was added to the Superfund National Priorities List on June 14, 2001 (Superfund Identification Number: NYSFN0204269).

Removal and investigative activities at the Site have been managed by IBM pursuant to the EPA Administrative Order on Consent for Removal Action, Index Number: CERCLA-02-2001-2020 (Removal AOC) with an effective date of May 16, 2001 and; EPA Administrative Order on Consent for Remedial Investigation/Feasibility Study (RI/FS) Index Number: CERCLA-02-2002-2025 (RI/FS-AOC), with an effective date of October 2, 2002.

Together with EPA, IBM completed the removal action for contaminated soils at the Facility. In addition, other actions were undertaken pursuant to the Removal AOC most notably: installation of a permanent public water supply from the Town of Fishkill municipal system within the Shenandoah Town Water District (STWD) to replace the use of individual residential supply wells.

Under the RI/FS AOC, IBM completed an extensive Remedial Investigation (RI) for the Site to delineate the occurrence and extent of volatile organic compounds (VOCs) in groundwater beneath the Site. The Site-related COCs are PCE and its degradation products, trichloroethylene (TCE) and cis-1,2-dichloroethylene (cis-1,2-DCE).

In addition, under the Removal AOC, the NTCSRA (non-time critical source removal action) was initiated in March 2012 which involved the installation and ongoing operation of the SETS (source extraction and treatment system) at the Facility for the purpose of controlling groundwater chemical flux from the remaining dense non-aqueous phase liquid (DNAPL) source in bedrock and to reduce mass contained in this source over time. Plate 2 shows the Facility Plan for the SETS: the location of the four groundwater extraction wells, double-walled conveyance piping, the groundwater treatment facility (GTF) and the outfall. The source removal, alternate water supply and other cleanup actions have significantly reduced the threat of release and potential impact to groundwater; however, groundwater plume response and continued operation of the SETS have been identified as components of the selected remedy in the ROD.

Following the RI, a feasibility study (FS) was conducted to develop and evaluate remedial alternatives for Site groundwater to reduce or eliminate unacceptable risks to human health and the environment from exposure to contaminated groundwater in the DNAPL source area at the Facility and throughout the groundwater plume in bedrock and glacial-sediment aquifers. The results of the FS were used to develop the Proposed Remedial Action Plan (PRAP) and the ROD for the Site.

In the ROD, EPA selected "Monitored Natural Attenuation (MNA) for Groundwater Plume and Source Extraction and Treatment" to address the groundwater contamination at the Site. The SETS consists of four groundwater extraction wells with associated groundwater treatment and was a previously approved action implemented under the Removal AOC as the NTCSRA.

The Site is currently listed as a Class 2 Site (Site # 314104) in the Registry of Inactive Hazardous Waste Disposal Sites in New York State and was issued a NYSDEC SPDES Equivalency Permit with an effective date of April 2, 2012 which details the effluent limitations and monitoring requirements for the treated groundwater remediation discharge (Outfall 001) from the SETS.

1.2 Physical Setting and Groundwater Plume Area

As shown on Figure 1-1, the Site is located in the Town of East Fishkill just north of the boundary separating Dutchess County from Putnam County, New York. Topographically, the Site is situated at the northern edge of the Hudson Highlands represented on Figure 1-1 by the presence of four prominent mountains that rise above the adjacent valley of Fishkill Creek: Honness Mountain; Round Mountain; Shenandoah Mountain and; Hosner Mountain.

Plate 1 presents a topographic map of the Shenandoah area. As circumscribed by the orange line on this plate, the maximum dimensions of the groundwater plume containing dissolved levels of PCE or one of its transformation products at a concentration greater than 5 ug/L are approximately 2,765 feet east to west by 5,580 feet north to south and it covers a total area of approximately 225 acres or 0.35 square miles.

The alleged source of this plume was historical operations at the Facility on a 2.0-acre parcel at 7 East Hook Cross Road, labeled on Plate 1 in the west central portion of the map area. This parcel is located in a small valley incised into the northern tip of Shenandoah Mountain. The plume emanating from this source extends north and south along Shenandoah Mountain and into valleys north and east of this ridge that are drained by three unnamed tributaries to Gayhead Creek also shown on Plate 1 (Stream Nos. 1-3), that are beyond the limits of the plume.

The valley to the east of Shenandoah Mountain contains a large wetland area identified on Plate 1 as NYSDEC Wetland HJ-59. Unnamed Stream No. 2 originates in a former sand and gravel pit. Unnamed Stream No. 3 rises in a broad flat valley north of I-84 and east of Shenandoah Road and is fed by a large wetland identified on Plate 1 as NYSDEC Wetland HJ-54. Along the southern edge of this wetland and just north of Townsend Road, Plate 1 shows a constructed pond adjacent to the southern edge of this large wetland.

Existing geologic mapping indicates Shenandoah Mountain is underlain by Precambrian gneiss and the adjacent valleys are underlain by carbonate rocks and, to a much lesser extent, quartzite and shale. Bedrock in the valleys is generally covered by a veneer of glacial sediments including bouldery till and ice-contact deposits ranging from coarse sand and gravel to fine-textured silt and clay. Till also partially fills the small valley occupied by the Facility to depths as great as 40 feet.

Land use along virtually all roads within the plume area is characterized by residential development where the slope of the land and the limits of wetlands will permit. At the time the plume was discovered each of these houses was served by a domestic water supply well and an on-lot sewage disposal system. All of 148 residential lots within and adjacent to the Site were included in removal actions that involved long-term residential well sampling and for most, the installation and maintenance of point of entry treatment (POET) systems. With the exception of eight homes (the homeowners declined water service), all are now served by a public water supply system constructed by IBM.

Prior to the soil removal action at the Facility in 2000-2002, PCE occurred at a maximum concentration in soil at the Facility of 11,000 mg/kg and in shallow groundwater (pit water) at 9900 ug/L. Since that action was completed, the results of the RI indicate the maximum concentration of PCE observed at the Site in groundwater is 16,000 ug/L in a well that monitors shallow bedrock groundwater believed to be affected by separate phase PCE that penetrated into the bedrock below the Facility.

Beyond the Facility, the maximum concentration of PCE in the plume observed during residential well sampling is 2100 ug/L. Concentrations in the northwestern portion of the plume have declined in some cases by more than an order of magnitude since the soil removal action was completed in 2002. Characterization sampling of soil gas, surface water and sediments have all confirmed crossover contamination in these media from VOCs dissolved in groundwater. The maximum concentrations of PCE in each of these media are as follows:

Soil gas:	11,000 ug/m^3;
Surface Water:	60 ug/L in a groundwater seep discharge to the wetland north of I-84; and
Sediments:	3.7 ug/kg in sediments within that same wetland.

1.3 Generalized Geologic and Groundwater Flow Conditions

While the installation of the public water supply has eliminated the drinking water exposure to contaminated groundwater, it has not restored the aquifers at the Site to drinking water or groundwater standards. Groundwater chemistry data collected under the RI shows that transformation of PCE to its daughter products occurs primarily in the eastern portion of the plume. Figure 1-2 shows a division of the plume into separate areas characterized by high and low ratios of

PCE to TCE, its principal transformation product at this Site. This figure also shows groundwater flow arrows and faults and shear zones in the bedrock. As demonstrated by this figure, groundwater flow from the Facility is strongly controlled by the structural features in the bedrock, which results in the plume being elongated along a north-south axis, and broadening to the north. Based on this figure, it can be seen that the low ratio portion of the plume attenuates in the vicinity of Jackson Road and Old Townsend Road, and the high ratio portion of the plume attenuates beneath Wetland HJ-54, both before reaching Stream No. 3.

Plate 3 is a schematic conceptual site model (CSM) showing the principal transport pathway associated with the high ratio portion of the plume. This figure also shows callouts depicting a mechanism termed “matrix diffusion” by which Site-related COCs are “stored” in pore water within the solid bedrock adjoining fractures that convey groundwater flow or in rock fragments that make up the sand and gravel of the ice-contact aquifer. This process and a related process known as adsorption onto organic carbon in the bedrock and rock fragments of the sand and gravel represent what is termed “secondary source factors”. This results from the fact that as the groundwater concentrations decline in these aquifers, this “stored mass” moves back from the bedrock or rock fragments into the groundwater. The effect is to extend the time necessary to reach groundwater concentrations that meet regulatory limits. At this Site, secondary sourcing is believed to be much more significant in the ice-contact deposits than in the bedrock aquifers.

Plate 3 depicts VOC transport within a vapor-phase component of VOC mass in the subsurface. The development of the vapor phase results from two mechanisms: direct evaporation of VOCs from residual DNAPL in the vadose zone and volatilization of VOCs from groundwater at the water table. With the removal of the DNAPL-contaminated soil from the Facility, it is believed that the only remaining source of vapor phase transport is associated with volatilization from the water table as depicted on Plate 3.

Plate 3 also shows contaminated groundwater flux discharging to the wetland north of the plume, Wetland HJ-54. Where groundwater flux has discharged to surface water in Wetland HJ-54, data indicate that the concentrations in surface water are rapidly attenuated and decline to non-detect levels before reaching Stream No. 3. The Screening Level Ecological Risk Assessment (SLERA) has concluded that the resulting concentrations in the wetland do not constitute an unacceptable impact to ecological receptors.

From the data collected under the RI, there is also substantial evidence of natural attenuation of the concentrations of Site-related COCs in groundwater. Overall, concentrations in the plume drop by at least an order of magnitude from the DNAPL source zone at the Facility (16,000 ug/L), to the nearby monitoring wells on Burbank Road (<1000 ug/L) and again by another order of magnitude as the plume crosses into the Paleozoic rocks and from there into the ice-contact deposits (<100 ug/L.

Although the plume covers an area of 225 acres and extends in places to depths greater than 400 feet below ground surface, Site-related COCs in the plume are attenuated by various mechanisms such that no evidence exists that any of these substances has impacted any of the three streams draining the area of the Site.

2 AVAILABLE RI SAMPLING LOCATIONS

Multiple media were sampled under the RI including: groundwater, groundwater seeps, surface water and sediments. Plate 1 depicts the location of these monitoring points. Figure 1-3 shows the location of collection pipes installed within the base of excavations at the Facility during the Soil Removal Action. Taken together, these sampling locations comprise the locations, and in the case of monitoring wells, intervals available to be included in the long-term CMP. The following subsections describe each of these sampling station categories. The results of sampling during the RI at each of these sampling points can be reviewed in the RI Report.

2.1 Groundwater Monitoring Wells

Beginning in September 2001, groundwater investigations were performed to better define the horizontal boundaries of the plume of PCE in groundwater at the Site. Under these initial groundwater investigations, some form of investigation was conducted at thirteen (13) wells. These thirteen wells include two existing domestic supply wells (SRDW-1R and SRDW-2R), one existing monitoring well (SRMW-3R); the remaining ten wells were drilled specifically for this initial investigation of the Site. In general, these initial investigation wells were located around the margins of the plume as defined by the results of sampling in these wells and the approximately 230 residential supply wells initially sampled by the NYSDOH.

Data were collected from eighteen monitoring wells during the Initial Groundwater Investigations (IGI) and the Alternate Water Supply Response Action (AWSRA). Of these wells, ten were drilled as part of the IGI from October 2001 to February 2002 (SRMW-1RA, RB, and RC, SRMW-2R and 2S, SRMW-4R and 4S, SRMW-5R and 5S and SRMW-6R). Another seven were drilled as part of the AWSRA from January 9, 2003 to March 12, 2003 (SRMW- 7S, 7R, 8R, 9S, 9R, 10S, and 10R). One well (SRMW-3R) was drilled by a property owner to supply a dwelling that had not been built at the time of the IGI. During the IGI samples were also collected from two recently drilled residential supply wells, SRDW-1R and SRDW-2R, which were subsequently incorporated into the residential well sampling program.

Under the RI, monitoring wells were drilled at ten additional locations (SRMW-11 through SRMW-20) also shown on Plate 1. Twenty-six borings with twenty-nine individual wells were completed between August 1, 2006 and June 21, 2007 including eight wells that monitor groundwater in saturated soil installed where there was sufficient saturated soil thickness to warrant discrete monitoring. In general, wells installed under the RI were located within the plume to permit better definition of the vertical distribution of COCs in the sand and gravel and bedrock units and to provide data to permit a better understanding of flow paths the transport PCE away from the Facility.

For reference, wells that monitor saturated soil contain an “S” suffix in their name and wells that monitor groundwater in bedrock contain an “R” suffix. Monitoring of multiple levels at the same well location was accomplished in more than one way: drilling multiple individual bedrock wells in a cluster at the same location as was done at the SRMW-18 cluster; by creating a cluster of one or more bedrock wells with one or more soil wells as was done at SRMW-12 where there are three soil wells and two bedrock wells and; through the use of FLUTe multi-level monitoring systems.

The number of discrete monitoring intervals at several locations (SRMW-12RA/RB, SRMW-12RC/RD and SRMW-14RA/RB) was further enhanced by the construction of a conventional 2-inch diameter well inside each of the 6-inch bedrock boreholes, with the annular space left open above a bentonite seal to allow monitoring of a shallower WBZ in the annular space between the 6-inch diameter borehole and the 2-inch diameter riser pipe.

FLUTe multi-level monitoring systems are custom made flexible well liners that are prefabricated to provide a discrete sampling and water level monitoring interval as long as 20 feet at any pre-determined depth within a borehole. This technology is currently in use at SRMW-1RA, 1RB, 4R, 11R, 14R, 15R, 16R, 17R and 18RF. The well with the greatest number of FLUTe monitoring intervals is SRMW-17R, which was equipped with a FLUTe liner constructed with seven discrete monitoring intervals in one 500 foot deep borehole. FLUTe liners had been used at SRMW-18RB, SRMW-18RC and SRMW-18RE prior to the conversion of these wells into extraction wells.

Intervals selected for discrete monitoring using any of these strategies were selected on the basis of geologist logs, packer tests, and geophysical logging and borehole testing by the USGS. The depth intervals and well construction details for all monitoring wells are shown on the well logs in Attachment A and in the physical well data table in that same attachment.

2.2 Residential Wells Converted for Long-term Monitoring

As noted previously, groundwater sampling had been conducted at approximately 146 residential water supply wells generally on a quarterly frequency 2000 to 2009. Since the installation of the public water supply system was substantially completed in 2009, with the exception of eight wells discussed previously, all of the properties served by these residential wells were connected to the public water supply and the use of these wells for water supply purposes was discontinued.

Concurrent with the transition from the private supply wells to the public system, twenty-six (26) private supply wells were identified at which it appeared to be appropriate to continue the long-term groundwater sampling program which began in 2000. In general, the techniques applied to convert the residential wells for long-term monitoring included the following considerations: 1.) Sampling the well in the same configuration it was sampled as a supply well if there is only one prominent WBZ; 2.) Constructing a 2-inch diameter conventional PVC monitoring well inside the nominal 6-inch diameter supply well to monitor the lowermost of multiple WBZs while leaving the annular space between the 2-inch well and the 6-inch borehole open to allow monitoring of a shallower WBZ and; 3.) The limited use of passive diffusion bags (PDBs) where two or more WBZs remain in the same open borehole interval and no vertical gradient had previously been observed. Intervals selected for discrete monitoring using any of these strategies were selected on the basis of monitoring results and geophysical logging and borehole testing by the USGS. Final construction logs for the residential wells converted for long-term monitoring can be found in Attachment A.

2.3 Shallow Facility Groundwater (Pit Water)

In the bottom of the Large Pit Excavation at the Facility, EPA placed 6.5 feet of crushed gravel. Within the crushed gravel layer, EPA installed 6-inch diameter horizontal, perforated, schedule 40

PVC pipe 16 inches above the base of the gravel layer. Three, 6-inch diameter schedule 40 PVC riser pipes were then connected to the perforated pipe to allow access to this underdrain system. The bottom five feet of these riser pipes is perforated and the remainder is solid. Geotextile material was then placed on top of the gravel layer to prevent soil from washing into the gravel after backfilling. On Figure 1-3, this underdrain system is labeled as " Large Pit Water Collection Pipe" and shows the locations of three vertical pipes extending upward from the single, common horizontal perforated pipe. Water present at any given time in any one of these three pipes is therefore representative of water contained in their common horizontal collection pipe.

In addition to the underdrain system installed in the Large Pit Excavation, three groundwater collection systems were installed on bedrock in the base of the acid pit excavation to allow access to the water table at the bedrock/overburden interface. These are labeled on Figure 1-3 as “Northern Water Collection Pipe”, “Central Water Collection Pipe”, and “Southern Water Collection Pipe” and each one separately accesses a set of U-shaped or H-shaped perforated horizontal drain pipes in the bottom of the Acid Pit Excavation.

2.4 Groundwater Seeps

To assess groundwater flux to surface water, four groundwater seeps were identified at the southern end of NYSDEC Wetland HJ-54 (shown as SRSP-1 to 4 on Plate 1) and sampled in May and June 2012. The seep associated with the lowest temperature (i.e., comparable to groundwater) and the highest Site-related COC concentrations was SRSP-03. The COC concentrations reported for this seep are comparable to the groundwater results detected in well SRMW-12S, located immediately upgradient from the location of this seep (Plate 1).

2.5 Surface Water and Sediments

The surface water and sediment sampling locations were chosen to address all likely areas where any Site-related COCs could be transported by groundwater. Nine co-located surface water and sediment stations were identified in the RI Work Plan (SRSW/SRSD-1 to 9 on Plate 1**)** and include locations within both wetlands (NYSDEC Wetland HJ-54 and HJ-59). Sixteen sampling locations were added in NYSDEC Wetland HJ-54 following analysis of groundwater transport pathways

(SRSW-10 in 2009 and SRSW/SRSD-11 to 25 in 2012 on Plate 1). Detectable concentrations of COCs were found in samples from five of these surface water sampling stations (SRSW-12, SRSW-13, SRSW-14, SRSW-18 and SRSW-21) and in six of the sediment samples (SRSD-11, SRSD-12, SRSD-13, SRSD-14, SRSD-18 and SRSD-21).

3 MONITORING PLAN

The Monitoring Plan includes extensive groundwater and surface water/sediment monitoring to provide the data needed to confirm projections of time to cleanup of the groundwater plume by natural attenuation (i.e., by dilution and dispersion) currently based on existing data and modeling. Monitoring information collected under this CMP, therefore, will also provide a basis for any changes in the remediation plan for the Site.

Groundwater monitoring will be performed for two principal purposes: to track the progress of concentration reductions throughout the Site, including by active extraction and treatment in the source area and by MNA within the plume; and to assess the hydraulic effectiveness of the SETS in preventing groundwater chemical flux from the source area at the Facility.

The following subsections describe these components of the CMP.

3.1 Source Extraction and Treatment System (SETS)

Since the soil contaminated with levels of PCE typical of a DNAPL source was removed, the remaining DNAPL zone in the bedrock beneath the Facility constitutes the only remaining primary source of continued contamination to the groundwater. Implementation of the SETS is designed to control the groundwater chemical flux from the source area at the Facility, specifically VOCs, and to diminish the DNAPL source in bedrock to levels that no longer require such control; however, that goal is not expected to be achieved until fifteen years after startup. In the interim, monitoring is necessary to determine the effectiveness of this action in meeting both of these objectives.

The Site was issued a SPDES Equivalency Permit, with an effective date of April 2, 2012, by the NYSDEC for the treated groundwater remediation discharge (Outfall 001) from the SETS with associated monitoring requirements.

3.1.1 Hydraulic Effectiveness Monitoring

Groundwater levels will be monitored within the Site to assess the hydraulic capture zone of the SETS. Groundwater level measurements at the four extraction wells will be recorded electronically through the use of pressure transducers connected to the PLC device located within the GTF. These readings will be compared with manual measurements taken at least monthly and measurements will be recorded in the Operator Log Book (RD/RA Work Plan, Appendix A, Source Extraction and Treatment System Operation, Maintenance and Performance Monitoring Manual).

Groundwater levels in the monitoring well network will be recorded electronically through the use of pressure transducers deployed as part of the multi-level sample assembly, the FLUTe sampler, or deployed within the well casing. Where transducers are deployed, these measurements will be recorded to the nearest 0.01 foot. These readings will be compared with manual measurements taken at least once quarterly. The manual groundwater level measurements will be recorded on the appropriate field data forms (QAPP, Tab A, Sample Forms).

A pattern of continuously rising groundwater levels in the monitoring well network or extraction wells without corresponding regional water table changes will be investigated. Likewise, reduced capacity of extraction wells may indicate the need for redevelopment or other well head maintenance.

3.1.2 NYSDEC Effluent Limitations Monitoring Requirements

Samples will be collected of the final effluent of the treatment system at the treated groundwater remediation discharge (Outfall 001) as per the Site New York State Effluent Limitations and Monitoring Requirements (Site Number 3-14-104, dated April 2, 2012) (Attachment B).

The current monitoring requirements include monthly monitoring at Outfall 001 for select VOCs, including the COC PCE, pH, Total Dissolved Solids and thirteen metals. Flow is to be monitored on a continuous basis by metering and the flow cannot exceed a daily maximum of 43,200 gallons per day.

A Discharge Monitoring Report will be prepared monthly and will summarize the data specified in the Effluent Limitations and Monitoring Requirements and will be submitted to the NYSDEC and EPA electronically as per the NYSDEC Division of Environmental Remediation (DER) Paper Reduction Initiative request.

3.1.3 Performance Monitoring of the SETS

Monitoring the performance of the SETS will include sampling of the source area extraction wells, the shallow facility groundwater (pit water) and wells within the monitoring network.

3.1.3.1 Groundwater Extraction Wells

Monthly sampling of the Source Area Extraction Wells will be conducted under the CMP for Site COCs plus VC. Flow rates and daily flows will be recorded under the Operations, Maintenance and Monitoring Plan (OM&M Plan, Appendix A of the RD/RA Work Plan) and reported in progress reports as described in the RD/RA Work Plan.

3.1.3.2 Shallow Facility Groundwater (Pit Water)

Historically, some of these pit water pipes have been dry. Concurrently with the quarterly sampling activities and to the extent practical coincident with the sampling of the groundwater extraction wells, sampling will be conducted of the shallow facility groundwater at the four pit water pipes for Site COCs plus VC.

3.1.3.3 Groundwater Monitoring for the SETS

Although the implementation of the SETS is designed to control groundwater chemical flux from the source area and to diminish the DNAPL source in bedrock to levels that no longer require such control, that goal is not projected to be achieved until fifteen years after startup of the source extraction and treatment system. Groundwater monitoring is necessary to determine the effectiveness of the SETS in meeting both of these objectives. The wells included in groundwater monitoring for the SETS effectiveness were part of a previously approved monitoring plan implemented under the NTCSRA Removal Action.

The SETS monitoring in twenty-six (26) monitoring wells / intervals at 14 well locations as shown on Plate 4 and detailed in Attachment C is focused on confirming progress toward attainment of the Remedial Action Objectives (RAOs) for the SETS.

3.2 Monitored Natural Attenuation

Based on the fate and transport analysis in Section 5 of the RI Report, it is anticipated that the concentrations of individual COCs in groundwater in bedrock aquifers would be reduced by natural attenuation to levels below the New York State Drinking Water and Groundwater Standards for all three COCs of 5ug/L in fifteen years or less. This estimation of the time to achieve these RAOs in bedrock groundwater is based on projections of groundwater concentration trends in bedrock wells in which water quality improved markedly after the soil removal action was completed in 2002. These projections suggest an overall time period to achieve 5 ug/L in these wells may be on the order of 20 years from March 2002. However, this is without the flux control benefits that were gained from implementing the SETS. This additional source control/reduction action combined with the likely low significance of secondary sourcing in the bedrock aquifers results in the estimation that the time to achieve RAOs would be fifteen years or less, based in part on experience with similar contaminants and similar hydrogeology elsewhere in the Hudson Highlands of New York. However, additional monitoring over an extended period of time is required to refine the estimation of this rate of decline in COC concentrations.

While Section 5 of the RI Report also documents that PCE is being transformed into its daughter products at several well locations within the bedrock plume, these transformations are incomplete. No ethene was detected in MNA sampling results over three bimonthly sampling rounds conducted from January to May 2012. Therefore, the attenuation of PCE that has been observed over the past ten years since the soil removal was completed resulted from a reduction of the source factor and subsequent dilution and dispersion of the remaining dissolved PCE in both the crystalline and Paleozoic bedrock aquifers, in the apparent absence of significant impacts from secondary sourcing. Based on these observations, projected future attenuation of COC concentrations in the bedrock aquifers is anticipated to result from dispersion and dilution of dissolved COCs in bedrock groundwater as the remaining source factor is eliminated by the operation of the SETS with little, if any, attenuation occurring as a result of transformation of PCE to its daughter products.

The discussion in Section 5 of the RI Report also addresses attenuation in the glacial sediments aquifer. Because of the apparent influence of secondary sourcing on COC concentrations in this aquifer, COC concentrations in groundwater within this unit are not expected to reflect the same rate of attenuation as in the bedrock groundwater in response to the operation of the SETS. As described in that report, a 50% reduction in concentrations is anticipated to occur in as little as four years or as long as twelve years. Nonetheless, the projections for this aquifer also indicate achieving RAOs in this unit may take as long as 30 years or more. However, the existing number of samples and period of record for the wells monitoring this unit are both limited and, as in the case of the bedrock aquifers, additional monitoring to observe the response over time to operation of the SETS will be necessary to refine these projections.

With the preceding technical rationale in mind, a sampling and analysis plan (SAP) has been developed for MNA (MNA SAP) to observe improvements in groundwater throughout the plume and surface water/sediment quality in Wetland HJ-54 that are expected to occur as a consequence of:

- The operation of the source extraction and treatment system,
- The resultant elimination of flux to the plume, and
- The anticipated attenuation of COC concentrations as the remaining limited mass of COCs in the plume is diluted and dispersed over time.

Effective monitoring of natural attenuation processes involves a three-dimensional approach to network design. Data are used to evaluate changes in plume boundaries, contaminant concentration and geochemical changes that may indicate changes in remedial performance.

The MNA SAP consists of locations within the source area, locations associated with higher concentrations within the plume area, locations associated with lower concentrations along the plume boundary, and a groundwater seep, surface water and sediments of Wetland HJ-54. Specific details for each of the media monitored is provided in the following subsections.

3.2.1 Groundwater Plume Monitoring for MNA

Sampling and analysis to monitor the effectiveness of the MNA component of the remedy will be conducted at those locations identified on Plate 4 and summarized in Attachment C. Under this component of the CMP, sampling and analysis will be conducted at thirty-four (34) well locations /

intervals to track the rate of COC concentration reductions following the startup of the SETS in March 2012. Beyond the Facility, transport of VOCs in groundwater is to the north, south and east. The maximum concentration of PCE in this plume has been observed during residential well sampling to be 2100 ug/L at BRB009 (Plate 4).

The extent of the plume is shown on Plate 4 by an orange line that circumscribes all aqueous phase detections of COCs exceeding NYS drinking water and groundwater standards. As shown on this plate, locations /intervals selected for MNA monitoring are highlighted in yellow. As can be seen on this plate, the MNA SAP includes locations within the source area, within the plume area and also locations along the plume boundary. The MNA SAP was developed with consideration for inclusion of:

- higher concentration source area wells;
- lower concentration wells along the margins of the plume area;
- locations where transformations of PCE to TCE and cis-1,2-DCE are evident based on the data collected under the RI;
- locations where concentrations of the COC PCE are declining based on the data collected under the RI and;
- locations to provide for vertical definition.

3.2.2 Groundwater Seep

One (1) groundwater seep location, SRSP-03 shown on Plate 4, has been identified for ongoing, routine monitoring in the southern portion of NYSDEC Wetland HJ-54. This location was selected because it recorded the highest concentration of the COC PCE and the lowest temperature along the seep line discovered within the wetland. Monitoring of this seep, together with the well cluster at the SRMW-12 location will document the progressive reduction in COC concentrations in this wetland and the groundwater discharging to it.

3.2.3 Surface Water and Sediments Sampling

Four (4) surface water/sediment sampling locations have been identified for ongoing, routine monitoring in the southern portion of NYSDEC Wetland HJ-54. These sampling locations were selected because, together with the groundwater seep location mentioned above, they document the progressive reduction in COC concentrations in this wetland with distance from the groundwater seep area and as such are included in the MNA component of the CMP. These four locations, SRSW/SRSD-12, SRSW/SRSD-13, SRSW/SRSD-14 and SRSW/SRS-18, are identified on Plate 4 and are included in the MNA SAP presented in Attachment C of this plan.

3.3 Monitoring Parameters

As described in Section 2, an extensive RI was completed to delineate the occurrence and extent of VOCs in groundwater beneath the Site. As a consequence of that investigation and the results of the BHHRA, the Site-related COCs are PCE and its degradation products, TCE and cis-1,2-DCE, which have been incorporated, as appropriate, in the RAOs presented in the ROD. Therefore the list of VOCs for which analyses will be performed is limited to the COCs PCE, TCE and cis-1,2-DCE plus their additional degradation product, Vinyl Chloride (VC) (Site COCs plus VC).

Furthermore, an evaluation of MNA-parameter results presented in the RI Report shows that only Dissolved Oxygen (DO) and nitrate-N correlate strongly with the occurrence of reductive dechlorination in groundwater at the Site. Therefore, the list of MNA parameters is limited to DO and nitrate-N. The tables in Attachment C, Monitoring Schedules identify the wells/intervals at which analyses for these MNA parameters will be performed. This list includes some wells/intervals otherwise included in the 24 being monitored for SETS effectiveness.

3.4 Monitoring Frequencies

In all, sixty monitoring wells/intervals are listed in the monitoring plan in Attachment C and shown on Plate 4. For the first five years, twenty-seven are assumed to be sampled quarterly, eighteen semiannually and fifteen annually, representing a total of 159 groundwater samples per year. Five groundwater seep and surface water/sediment sampling locations are also listed to be sampled quarterly for a total of twenty samples per year. Shallow facility groundwater (Pit Water) locations are listed to be sampled quarterly for a total of sixteen samples per year.

The Monitoring Plan presents a frequency for each location which varies depending on the time elapsed since the SETS operation began. As noted above, for the first five years, monitoring frequencies are quarterly, semiannual and annual to provide a sufficient number of results to permit more accurate projections of cleanup times. For years six to fifteen, it is assumed that the sampling frequency for wells shown initially as quarterly would be reduced to semiannual, and those noted as semiannual would be reduced to annual. The initial annual wells would all still be sampled on that frequency to provide a full snapshot of concentrations throughout the plume each year.

At the end of the fifteenth year, it is anticipated that the SETS will be shut down and it will, therefore be necessary to perform post-termination sampling. Therefore, for years 16-18, it is assumed that the frequency of sampling would be returned to quarterly for those wells noted as such for years 1-5 in the monitoring plan. Sampling frequencies at all other wells would remain as they are for years 6 to 15. For years 19 to 30, it is assumed that continuing reduction in concentrations in the ice-contact deposits and the seeps and surface water/sediment is all that would remain to be monitored and only at the eleven groundwater and surface water/sediment sampling locations listed in that column in the monitoring plan at a semiannual frequency.

The CMP will maintain flexibility in the locations and numbers of monitoring points, in addition to the sampling frequency of individual locations and monitoring ports. As conditions warrant, locations can be added and/or removed to adjust to changes in the conceptual model and plume dynamics.

Frequencies for all monitoring locations are provided in Attachment C: Table C-1, Groundwater Monitoring Wells; Table C-2, Shallow Facility Groundwater (Pit Collection Pipes); Table C-3, Groundwater Seeps; Table C-4, Surface Water and; Table C-5, Sediments.

3.5 Future Modifications to the Monitoring Program

Modifications to the CMP will be accomplished by proposing the modifications in a letter to the EPA with appropriate technical justifications for the proposed changes. Modifications to the locations and sampling frequency will be reflected in revisions to the monitoring schedules presented in Attachment C as Tables C-1 through C-5, as appropriate, and Plate 4. The revised tables and plate will be appended to the CMP to reflect modifications to the program.

A revision number and date will be incorporated into the header of the revised tables and plate to reflect the most recent modification. In addition, a new CMP cover page with the appropriate revision number and date will replace the previous cover page.

4 SAMPLING PROTOCOLS

Sampling of all media will proceed as per the protocols and methods specified in the Quality Assurance Project Plan (QAPP), Attachment D to this plan, including the following:

- Section 1: Monitoring Well Maintenance, & Decommissioning Protocol

Describes the methods for surface completions, well inspections and associated maintenance and the well decommissioning protocol.

- Section 2: Groundwater Sampling Protocol

Describes methods to be used in the collection of groundwater quality samples.

- Section 3: Surface Water Sample Collection Method

Describes methods to be used in the collection of surface water quality samples.

- Section 4: Sediments Sample Collection Method

Describes methods to be used in the collection of sediments samples.

- Section 5: Pre-Sampling Preparation and Tasks

Provides an overview of pre-sampling preparation tasks including field equipment inspection and maintenance and interactions with the laboratory.

- Section 6: Personnel Protective Equipment / Health and Safety Measures

Provides a brief synopsis of Health and Safety measures for field personnel.

- Section 7: Field Quality Assurance / Quality Control (QA/QC) Requirements

Provides an overview of the types of samples to be collected under the CMP for field quality assurance and quality control.

- Section 8: Sample Numbering and Labeling

Provides guidance on assignment of a unique sample identification number for all trip blanks, equipment blanks, duplicates, and environmental samples.

- Section 9: Chain of Custody Procedures

  Details the chain of custody process which will allow for the tracing of possession and handling of individual samples from the time of field collection through laboratory analysis.

- Section 10: Sample Storage and Shipment

  Details proper sample storage and shipment methods to maintain sample integrity.

- Section 11: Laboratory Methods and Analytical Protocols

  Includes a listing of the approved laboratory methods and protocols .

All monitoring well sampling activities will be recorded in a field book on a sampling field data sheet (FDS) presented in the QAPP (Attachment D, Tab A, Sample Forms).

Other observations (e.g. well integrity, sampling location condition etc.) will be noted on either the field data sheet or physical well inventory forms presented in the QAPP (Attachment D, Tab A, Sample Forms). This physical well inventory form will serve as the inspection form for the groundwater monitoring well network.

5 INABILITY TO OBTAIN REPRESENTATIVE SAMPLES

This section describes the actions that will be taken when a well in the groundwater monitoring network cannot provide representative groundwater elevations or water quality data. In the event that it becomes necessary to remove a well from the sampling plan, the well will be properly decommissioned following the well decommissioning procedure in the QAPP (Attachment D, Tab A, Section 1: Monitoring Well Maintenance and Well Decommissioning Protocol).

5.1 Access Denied

If it is determined that a location cannot be monitored due to denial of access by a property owner, EPA will be notified of the problem after reasonable efforts have been made to re-establish access. If the problem persists throughout the quarter in which the sampling event is scheduled, reasonable and appropriate efforts will be made to renegotiate access before the next sampling event. If the property owner refuses to continue to participate in the sampling program or will only permit sampling less frequently than planned, a request will be made to EPA to modify the CMP to eliminate that sampling location or reduce its frequency to a level that the property owner will accept.

5.2 Well Damage

If it is determined that a well cannot provide representative samples or accurate piezometric values because it is damaged, EPA will be notified of the problem. The notification to EPA, will include information which describes the following: a) the nature of the problem, b) how the problem with the well has been rectified, and c) a schedule for repair or rehabilitation of the well.

5.3 Resampling

When it is determined that a sample has been collected or analyzed out of protocol, the affected sample will be re-analyzed if permitted under the QAPP, or the sampling point will be re-sampled for the affected parameters within twenty-one days of such knowledge, unless this requirement is waived by EPA after consultation.

5.4 Dry Wells

If any well does not contain sufficient water for a representative sample due to hydrologic conditions that lower water levels in monitoring wells across the Site (e.g., drought conditions), then the well will be examined biweekly during the remainder of the quarter in which that sampling event is occurring to determine when and if the water level rises to the point where it can be sampled. If there is no opportunity to sample the well during that sampling event, it will go un-sampled for one sampling event and that fact will be reported to EPA. The viability of the well will continue to be evaluated by additional water level measurements prior to the next scheduled sampling of the well. If this evaluation indicates that the well still does not contain sufficient water for a representative sample, then a proposal will be submitted to EPA to either replace the well or substitute another existing well. If a well is dry on a recurring basis due to groundwater extraction activities, it may go un-sampled until the extraction operations cease and water levels rise. Nonetheless, it will still be included in hydraulic effectiveness water level rounds to confirm that it is still dry.

6 WELL INSPECTION AND MAINTENANCE PLAN

The groundwater monitoring system will be maintained to ensure that all monitoring points yield representative samples.

The number for each well will be permanently affixed to or engraved onto the well casing or cap and maintained in a legible condition. Steel security casings will be painted and maintained as necessary to prevent corrosion. During each sampling event, contaminant monitoring wells will be inspected for integrity, the results of which will be recorded in the comments section of the FDS.

All monitoring wells will be inspected during one comprehensive physical well inventory on an annual basis. The physical well inventory form (QAPP, Tab A, Sample Forms) will serve as the inspection form for the groundwater monitoring well network. The results of this inspection will be used to develop a list of necessary well repairs and actions taken will be documented in progress reports. Depth to bottom measurements will be compared with reference depth to bottom measurements during all sampling and inspection activities. Should the depth to bottom measurement differ from the reference depth, the well must be redeveloped prior to the next scheduled sampling event.

Should a well or piezometer be found to be damaged beyond usability, blocked or broken, or fail to recharge properly or as expected, EPA will be notified. Should any significant cracking or frost heaving of grout be observed, repairs will be made and the measuring point resurveyed, to ensure accurate computation of groundwater elevations. All necessary repairs will be completed as soon as possible but not to exceed 120 days after identification of the problem

EPA will be notified prior to repair or replacement and the repair or decommissioning and replacement process will be documented in progress reports. Well decommissioning without replacement will be done only with the prior approval of EPA. Well decommissioning will be performed in accordance with the NYSDEC *Groundwater Monitoring Well Decommissioning Procedures*. Monitoring wells that are decommissioned because they have been rendered unusable will be reinstalled in the nearest available location, unless otherwise approved by EPA.

7 LABORATORY METHODS AND ANALYTICAL PROTOCOLS

All laboratories utilized under the CMP will have current and appropriate certification, New York State Department of Health Environmental Laboratory Program (NYSDOH ELAP), for the parameters analyzed. Laboratories performing the analyses must provide appropriate notice should certification lapse.

Laboratory analytical methods, documentation and reporting requirements are detailed in the Protocols and Standard Operating Procedures of the QAPP (Attachment D, Tab A, Section 11.0).

7.1 Documentation and Reporting Format

CLP deliverable reports will be prepared for samples collected and analyzed under this RD/RA Work Plan. Information regarding the analytical method, sample results, QA/QC results, chain of custody documentation, lab correspondence and raw data will be included in the CLP deliverables.

7.2 Laboratory Quality Assurance / Quality Control

Laboratories will follow QA/QC procedures specified in the approved analytical methods. The Laboratory Quality Assurance Project Plan (LQAPP) for each laboratory that may analyze samples for the Site under the CMP are presented in the QAPP (Attachment D, Tab B). The laboratories identified to analyze samples for the Site under the CMP are TestAmerica-Burlington of Burlington, Vermont and EnviroTest Laboratories of Newburgh, New York. Both labs have participated in the analysis of samples collected under the Removal Action and the RI. In the event that a change is made in the list of laboratories being used, the QAPP will be modified to include their LQAPP and this modification will be submitted to EPA for approval.

8 DATA REVIEW, MANAGEMENT & REPORTING REQUIREMENTS

The general flow of analytical data will be from the laboratory to the GSC Quality Assurance Manager, who will coordinate the work of the third party data validator, then to the GSC Project Manager, and finally, to the IBM Project Coordinator. Analytical data are then compiled in a summary format and are submitted to the EPA RPM with appropriate backup.

8.1 Data Review, Verification, and Validation

Laboratory results will undergo data review, verification and validation consisting of checks of chain-of-custody documentation, laboratory case narrative, holding times, duplicate results, blank results, and surrogate recoveries.

Data verification is the process for evaluating the completeness, correctness, and conformance/compliance of a specific data set against the method, procedural, or contractual specifications. It essentially evaluates performance against pre-determined specifications, for example, in an analytical method, or a software or hardware operations system. Verification of analytical data will be done by GSC after the data has been reviewed and prior to submitting the data to an independent third-party data validator.

Data validation is an analyte- and sample-specific process that extends the evaluation of data beyond method, procedure, or contractual compliance (i.e., data verification) to determine the quality of a specific data set relative to its end use. It focuses on the project's specifications or needs, designed to meet the needs of the decision makers/data users and should note potential departures from the procedures specified in the QAPP. Validation of analytical chemistry data will be performed by Veridian Environmental, Inc. a third-party data validator.

Data usability will be determined by a data quality assessment of the validated data, and may involve statistical evaluation (such as tests for outliers or trends) or scientific evaluation. A statistical analysis will result in quantitative statements about the quality of the data, while a scientific analysis will result in qualitative statements. Severe data quality problems may require that the data not be used, whereas some data may still be used even if some validations failed.

8.2 Data Management and Documentation

The laboratory will provide data following CLP data deliverable requirements and will follow the documentation procedures identified in their respective Laboratory Quality Assurance Project Plan (LQAPP) included in Attachment D.

Upon completion and resolution of data validation issues, the data will be entered into computer databases. Field and laboratory data will be stored in database files which contain certain field data such as the date and time of sampling, the sampler's initials, a unique field identification number, and a sample description; and certain analytical data such as parameter names, methods of analysis, reported results, and units of measure.

Groundwater elevation data is stored in computer spreadsheet and database files.

8.3 Reporting Requirements

Various reports and notifications must be provided to EPA to document the progress of remediation and to justify termination of specific remedial action elements. These range from progress reports to the final groundwater remedial action report.

8.3.1 Remedial Action Progress Reports

Reports, as detailed below, will be submitted to EPA, NYSDEC and NYSDOH describing activities and progress for work completed.

8.3.1.1 Source Extraction and Treatment System

The data obtained from the SETS will be tabulated, reviewed and interpreted on a continuous basis as it is collected. Progress reports will include documentation of overall SETS system performance and documentation that the system met the performance criteria.

In addition, progress reports will include a summary of monthly gallons extracted, chemistry and VOC mass removal by extraction well and will also include results from hydraulic monitoring interpreted to assess containment of the DNAPL source in bedrock and a summary of pertinent O&M information for the SETS.

8.3.1.2 Monitored Natural Attenuation

Implementation and progress of MNA for groundwater, as detailed in the approved MNA SAP component of the CMP (Appendix B), will be included in progress reports. A more detailed review will be prepared as part of the 5-year Comprehensive Review, which will include a summary of the results of the implementation of the MNA SAP for groundwater, surface water and sediment as required in the CMP and will describe the spatial and temporal trends in groundwater contaminant concentrations within the groundwater plume and the related progress of natural attenuation.

Analysis of trends, VOC, DO and nitrate-N monitoring data from both soil bedrock wells/intervals will be analyzed as part of the 5-year Comprehensive Review. A simple, statistically-based approach for evaluating the progress of natural attenuation will be applied to groundwater monitoring data from monitoring wells completed in the ice-contact deposits or former residential wells completed in each of the bedrock units as listed in the MNA SAP. This statistical analysis will be performed as specified in Appendix A of the EPA guidance document entitled *An Approach for Evaluating the Progress of Natural Attenuation in Groundwater* (December 2011). A first order rate law will be assumed for all wells because it appeared to fit the analysis of similar data in the RI Report. Analytical data from former residential wells collected prior to the completion of the 2000 to 2002 soil removal action will not be used in the trend analysis because the EPA guidance states that the best data to evaluate the progress of natural attenuation is the portion of the record that occurs after the completion of active source control. However, since there has been a source reduction in 2002 and subsequently a source control beginning in March 2011, the evaluation of data collected since 2002 will include trend analyses for all of the data collected since 2002 and separate analyses of data segments from 2002 to March 2011 and after March 2011. Graphs used in performing this analysis will also be presented as part of the comprehensive review.

8.3.2 Comprehensive Five-Year Reviews

Given that it is anticipated to take more than five years to achieve health-based cleanup levels in the groundwater, a review will be conducted within five years after initiation of remedial action to ensure that the remedy as selected is protective of human health and environment. Such reviews will be conducted no less often than once every five years until cleanup standards are achieved. The principal focus of these reviews will be to examine trends in groundwater, surface water and sediment quality in the data collected since the startup of the SETS. The analysis will also examine mass removal data and associated trends for the SETS since startup.

8.3.3 SETS Post-Termination Report

After 15 years of SETS operation, the CMP calls for three years of post-termination monitoring. Following the conclusion of this three-year post-termination monitoring for the SETS, a termination report will be prepared to document the potential rebound in groundwater concentrations that has or is projected to occur. The focus of this report will be to confirm that the RAOs related to the operation of the SETS have been achieved and will be maintained in the absence of further operation of the SETS. Until this report is prepared and EPA concurs with the continued shutdown of the SETS, the extraction wells and treatment system will be mothballed in a manner that will allow rapid restart of this system, if necessary.

8.3.4 MNA Termination, Post-Termination Tasks and Final Groundwater Report

It is anticipated that MNA monitoring will be conducted potentially for a period of thirty years. However, regardless of how long the MNA component of the remedy has been in place, once the RAOs associated with groundwater quality in the plume have been attained for a period of two years, IBM will notify EPA that the MNA component of the remedy is complete. At that time EPA will determine what, if any, additional tasks must be completed and IBM will prepare the work plan for these tasks and implement them after approval from EPA. Once these tasks have been completed to the satisfaction of the EPA, IBM will prepare and submit a Final Groundwater

Remedial Action Report, which will conform with the RA Report guidance incorporated in EPA's "*Close Out Procedures for National Priorities List Sites*", (EPA 540-R-98-016).

9 ASSESSMENT AND OVERSIGHT

The elements in this section address the activities for assessing the effectiveness of project implementation and associated QA and QC activities. The purpose of assessment is to ensure that the CMP is implemented as prescribed. Internal and external audits will be conducted to monitor the performance of the total measurement system and are described in detail in Section C.1 of the QAPP.

9.1 Field Performance and Systems Audits

Field performance audits will be conducted continuously as field data are generated, reduced, and analyzed. Numerical analyses, including manual calculations, will be documented. Records of numerical analysis will be legible, reproducible, and sufficiently complete so that they may be logically reconstructed.

A field systems audit of sampling activities will be accomplished at least annually by an audit team consisting of the IBM and GSC Quality Assurance Managers or designees. During this audit, the audit team will compare observed field practices with standard procedures and protocols.

Specific details on the components of the Field Performance and Systems Audits can be found in Section C.1.1 of the QAPP (Attachment D).

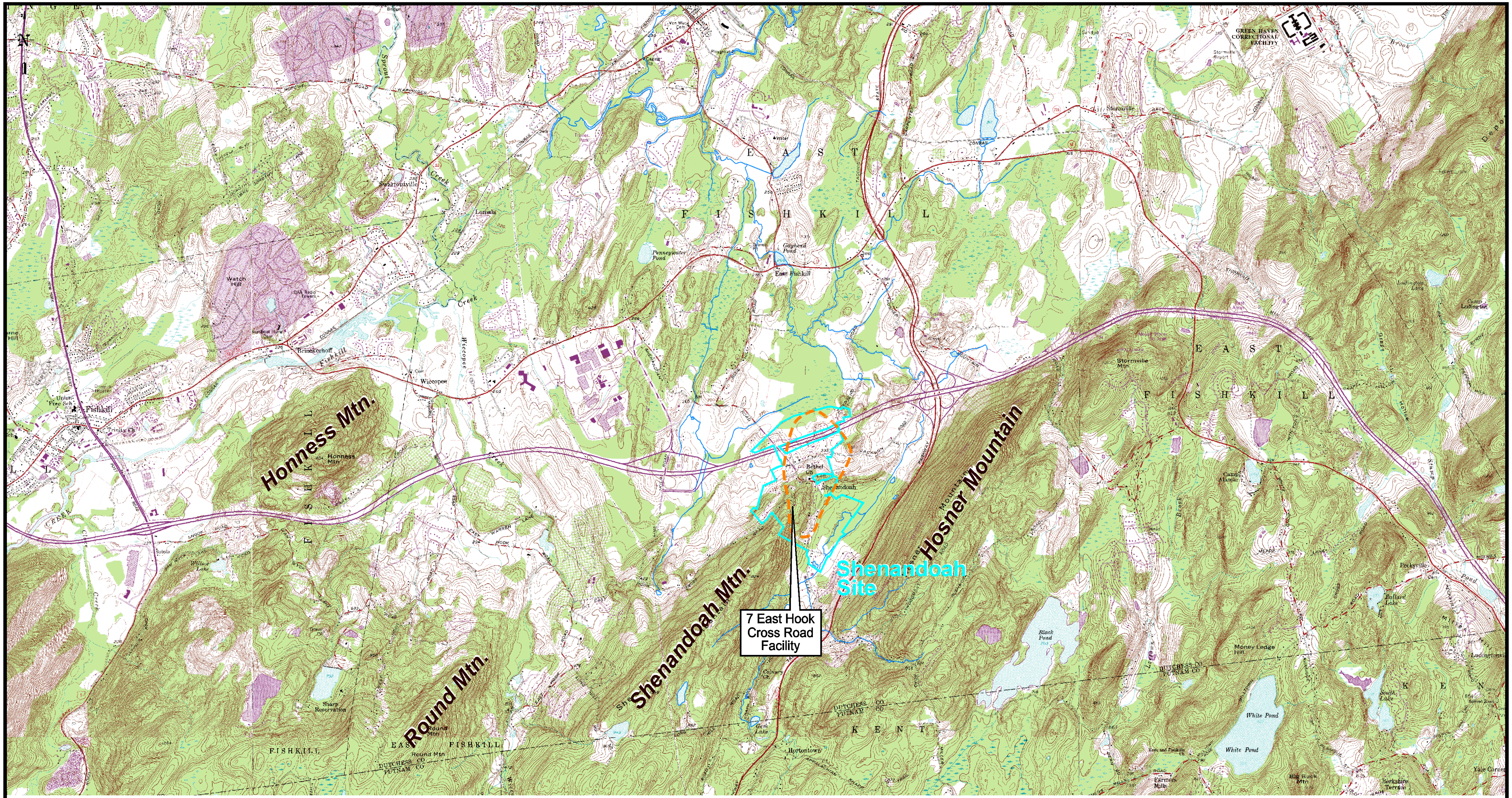
9.2 Laboratory Performance and Systems Audits

Laboratory systems audits are qualitative audits of the measurement systems and ensure that the systems are properly maintained and implemented. Laboratory performance audits will be conducted annually by an audit team and will include the following:

- Verification of written procedures.
- Level of understanding of analysts.
- Unannounced inspection of the sample handling group.
- Review of a portion of the analytical data and calculations.

Corrective action will be taken for deficiencies noted during the laboratory audits.

Specific details on the components of the Laboratory Performance and Systems Audits can be found in Section C.1.2 of the QAPP (Attachment D).



- Extent of Individual Site COPCs Detected Above 5 µg/L in Groundwater

Scale
0 2000' 4000'

Figure 1-1

Study Area Setting

Shenandoah Road Groundwater Contamination Superfund Site

GROUNDWATER SCIENCES CORPORATION

21003-007-C7 / 08-03-12

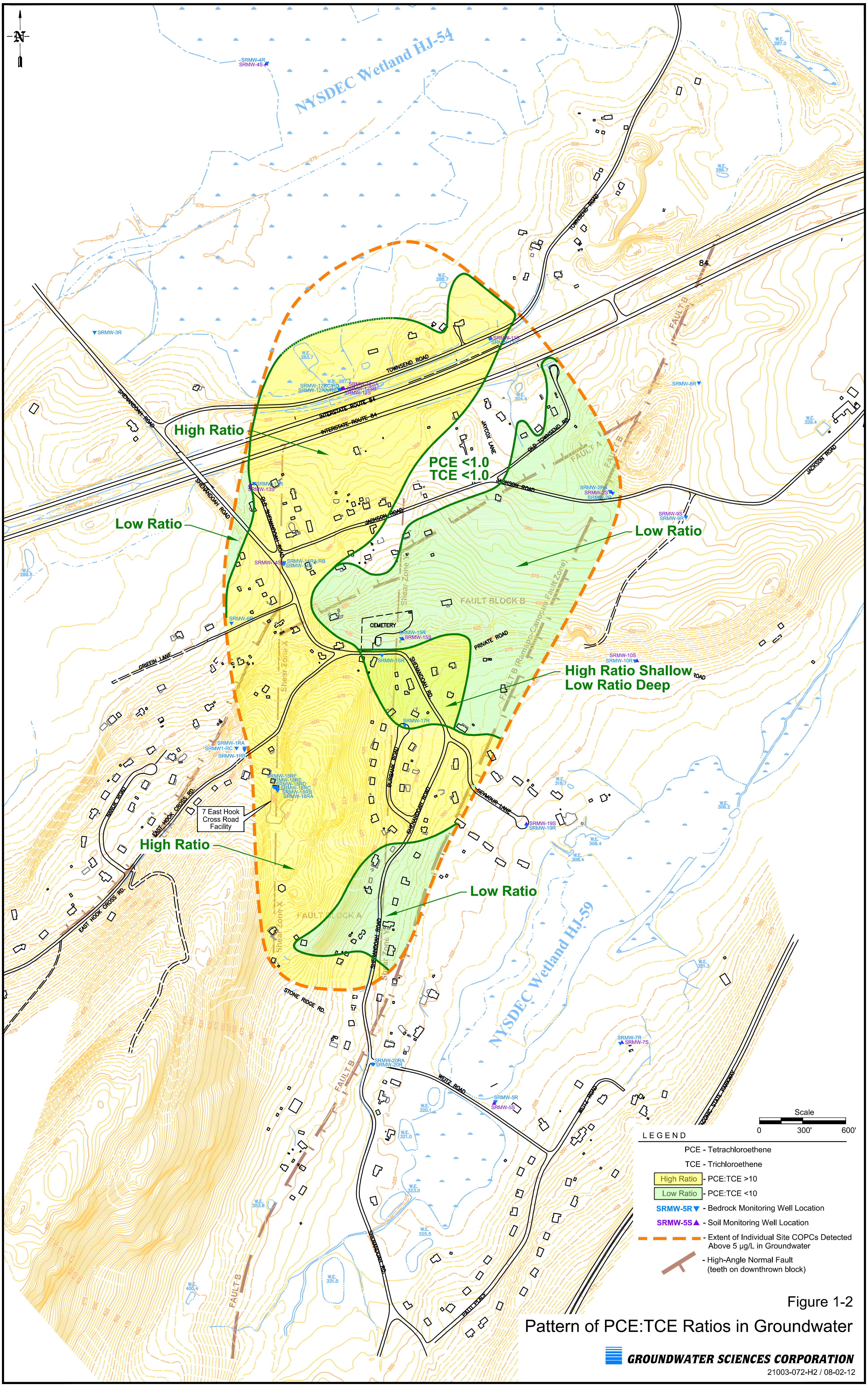
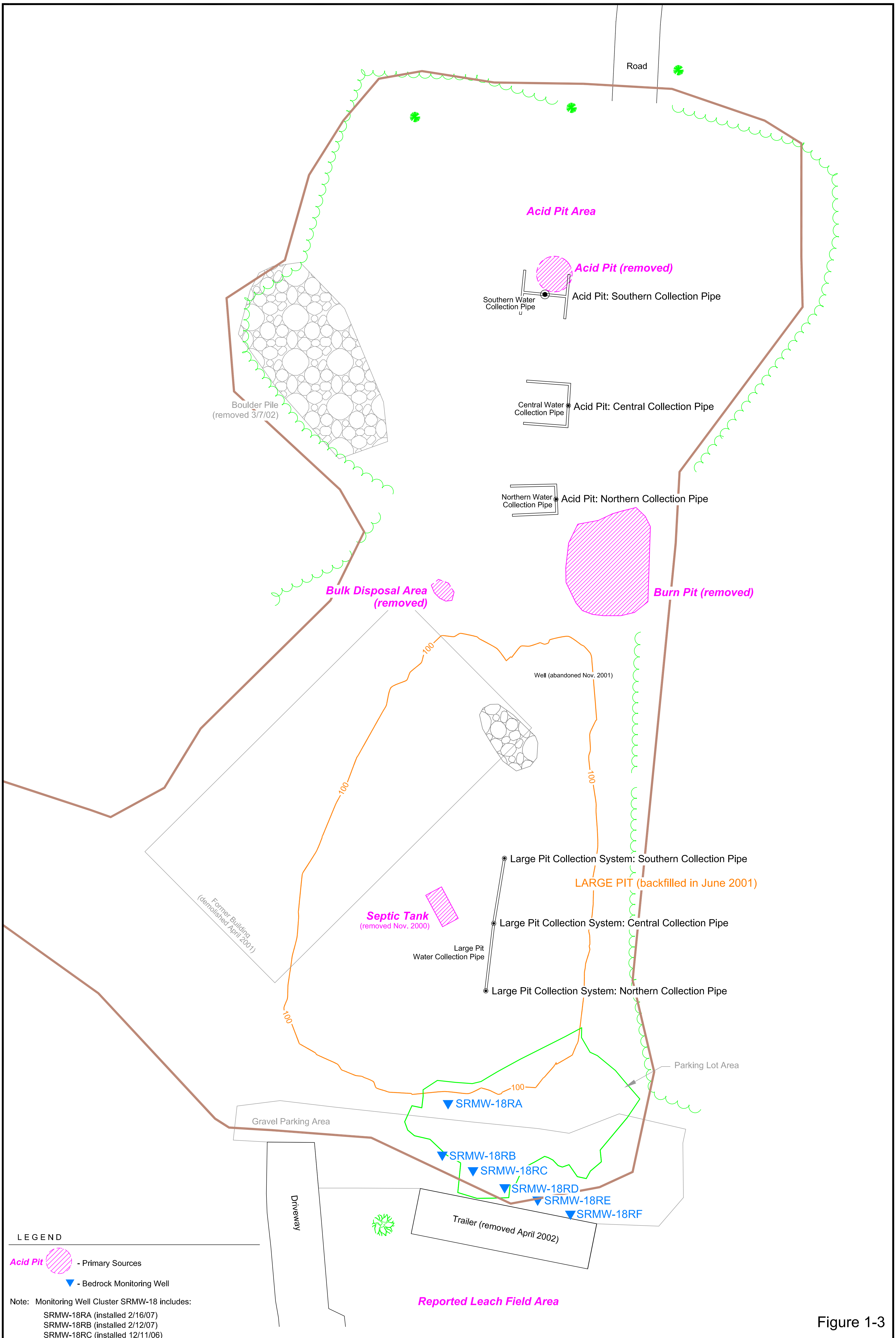


Figure 1-2

Pattern of PCE:TCE Ratios in Groundwater

GROUNDWATER SCIENCES CORPORATION

21003-072-H2 / 08-02-12



LEGEND

Acid Pit ▨ - Primary Sources

▼ - Bedrock Monitoring Well

Note: Monitoring Well Cluster SRMW-18 includes:

SRMW-18RA (installed 2/16/07)
SRMW-18RB (installed 2/12/07)
SRMW-18RC (installed 12/11/06)
SRMW-18RD (installed 12/22/06)
SRMW-18RE (installed 1/4/07)
SRMW-18RF (installed 2/2/07)

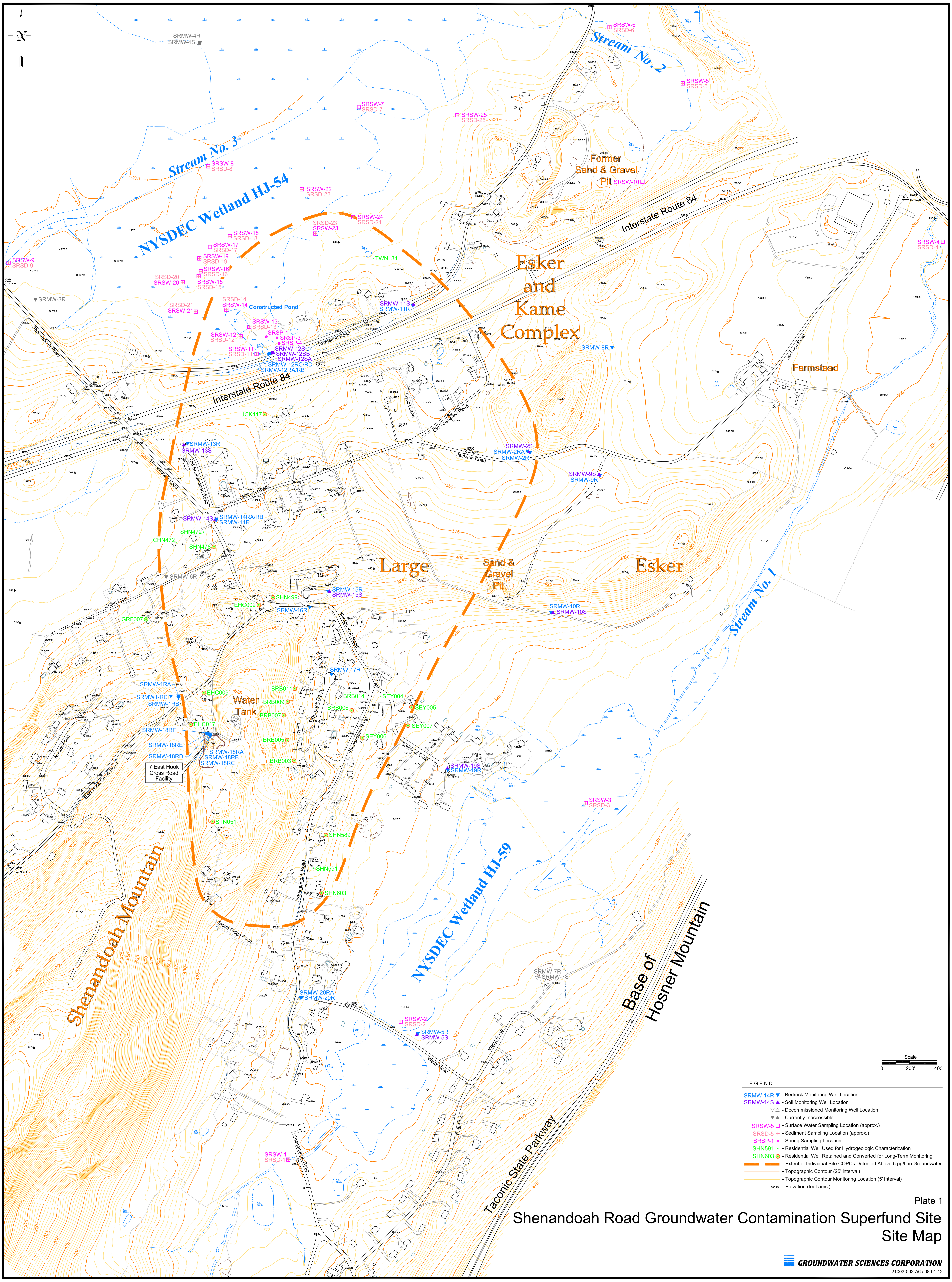
Scale
0 10' 20'

Source: Berger Engineering and Surveying, Poughkeepsie, NY.

Figure 1-3

Pit Collection Pipes
Shenandoah Road Groundwater Contamination Superfund Site
7 East Hook Cross Road Facility

GROUNDWATER SCIENCES CORPORATION
21003-052-05 / 06-27-13



LEGEND

- SRMW-14R ▼ - Bedrock Monitoring Well Location
- SRMW-14S ▲ - Soil Monitoring Well Location
- ▽△ - Decommissioned Monitoring Well Location
- ▼▲ - Currently Inaccessible
- SRSW-5 ☐ - Surface Water Sampling Location (approx.)
- SRSD-5 + - Sediment Sampling Location (approx.)
- SRSP-1 ● - Spring Sampling Location
- SHN591 • - Residential Well Used for Hydrogeologic Characterization
- SHN603 ◉ - Residential Well Retained and Converted for Long-Term Monitoring
- ▬ ▬ - Extent of Individual Site COPCs Detected Above 5 µg/L in Groundwater
- ― - Topographic Contour (25' interval)
- ― - Topographic Contour Monitoring Location (5' interval)
- 383.4× - Elevation (feet amsl)

Plate 1

Shenandoah Road Groundwater Contamination Superfund Site
Site Map

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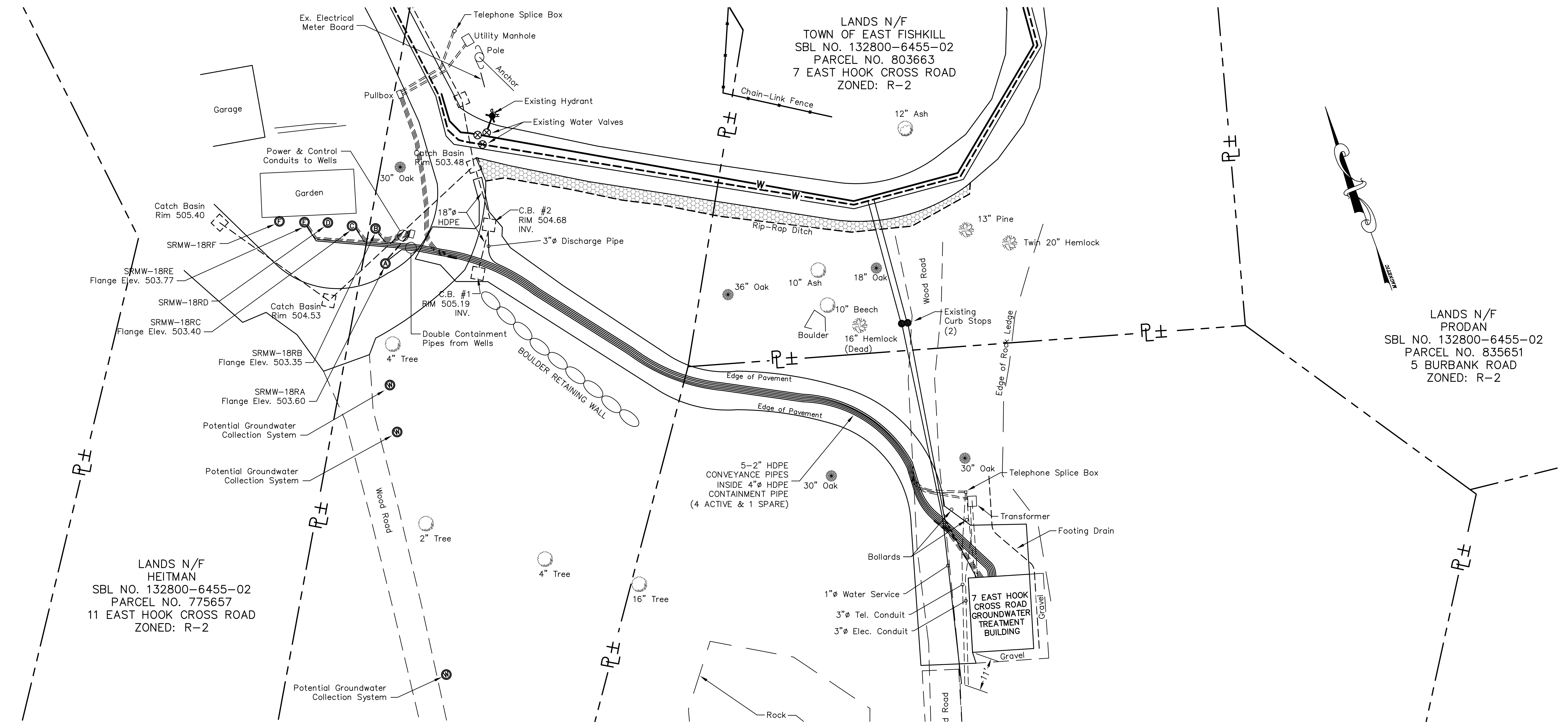
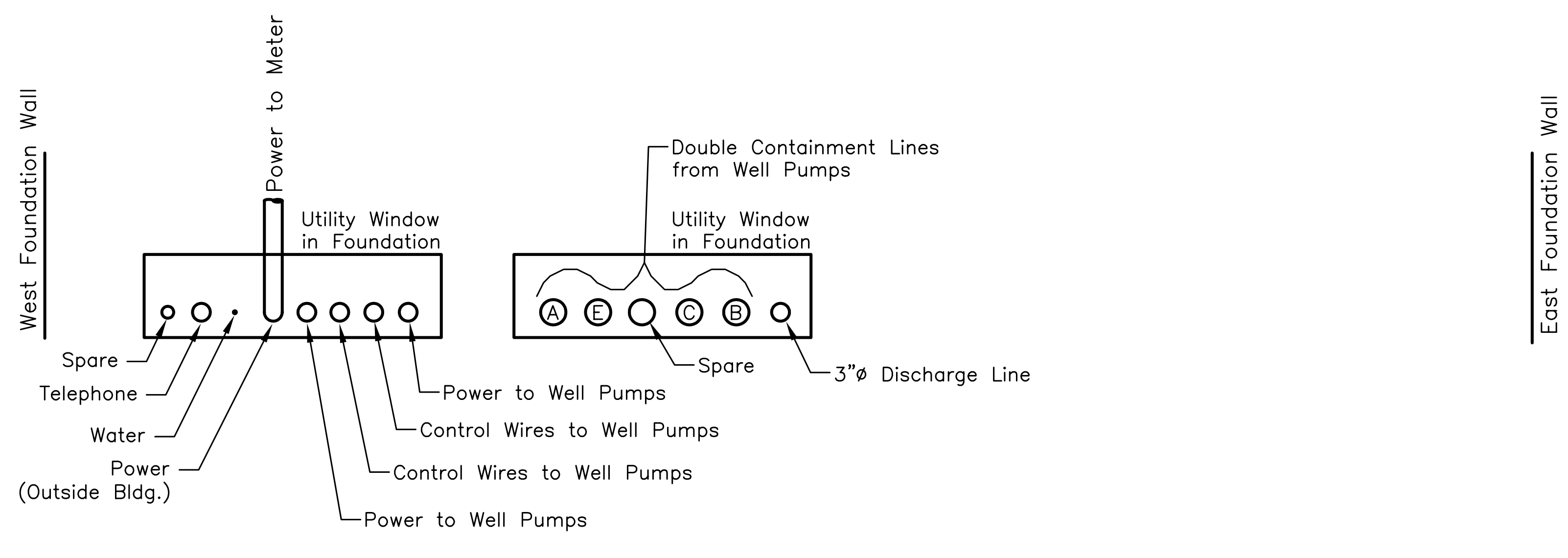
21003-092-A6 / 08-01-12





UTILITY LAYOUT THROUGH NORTH FOUNDATION WALL

NOT TO SCALE

AS-BUILTS

These as-built or record drawings have been prepared, in part, on the basis of information compiled and furnished by others. The engineer will not be responsible for any errors or omissions which have been incorporated into this document as a result.

DENNIS M. LARIOS 058747

CHRISTOPHER J. ZELL 49629

Unauthorized alteration or addition to a plan bearing a licensed engineer's seal is a violation of section 7209, subdivision 2, of the New York State Education Law.

SITE PLAN

Plate 2

7 EAST HOOK CROSS ROAD FACILITY
FOR THE
SHENANDOAH ROAD
GROUNDWATER CONTAMINATION SUPERFUND SITE
TOWN OF EAST FISHKILL DUTCHESS COUNTY NEW YORK

DATE	REVISION RECORD
6/20/12	Record Drawings

BRINNIER & LARIOS, P.C.
ENGINEERS & LAND SURVEYORS
67 MAIDEN LANE KINGSTON, N.Y.

SCALE	DATE		SHEET NO.
1" = 20'	SEPT. 2011		2 OF 7
	DWG WFP	CHK DML	

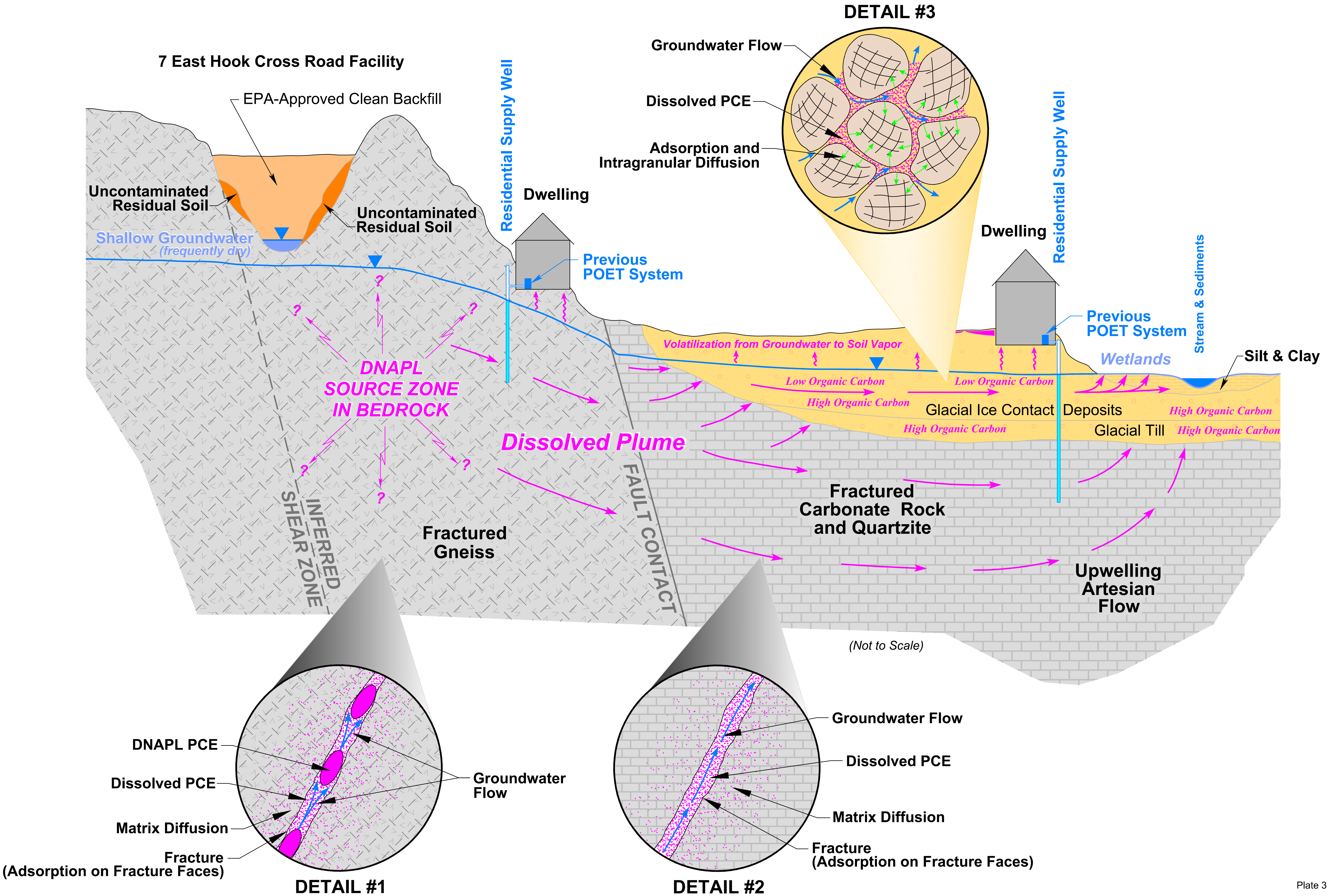


Plate 3
Schematic Conceptual Site Model
Shenandoah Road Groundwater Contamination Superfund Site

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21003-070-E6 / 07-03-12

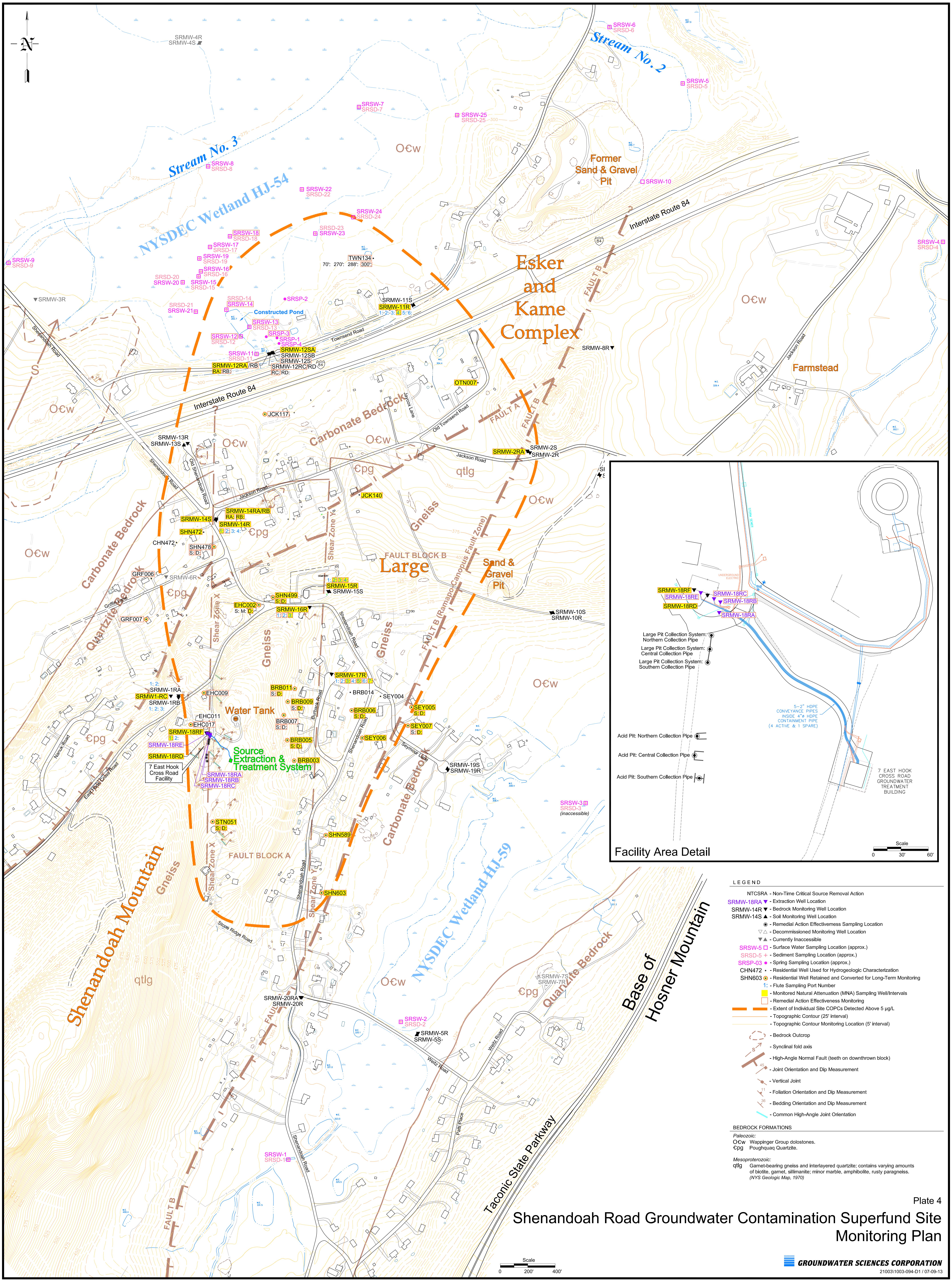

Plate 4

Shenandoah Road Groundwater Contamination Superfund Site
Monitoring Plan

GROUNDWATER SCIENCES CORPORATION

21003\1003-094-D1 / 07-09-13

Attachment A: Boring Logs and Monitoring Well Construction Details

A-1: Geologic and Well Construction Physical Data, Geologic Logs and Geophysical Logs

A-2: Residential Well Physical Data

A-1: Geologic and Well Construction Physical Data, Geologic Logs and Geophysical Logs

- A-1a: SRMW- Locations Physical Database
- A-1b: SRMW- Locations Well Logs
- A-1c: SRMW- Locations USGS Geophysical Logs

A-1a: SRMW- Locations Physical Database

Shenandoah Road RI/FS
Groundwater Monitoring Network Summary

Well Number	***Location***	***OH, CB, SCR Flute or ABA***	***Lithology of Open Interval***	***Elevation Grade (ft amsl)***	***Elevation TOC (ft amsl)***	***Flute Port Number***	***Sampling Interval (feet below grade)***	***Screened OH, or Sampling Interval (feet amsl)***		
SRMW-1RA	EHC Road	Flute	gneiss	481.8	483.50	1	345-375	136.8	-	106.8
			gneiss	481.8	483.50	2	430-440	51.8	-	41.8
SRMW-1RB	EHC Road	Flute	gneiss	482.57	484.89	1	50-65	432.57	-	417.57
			gneiss	482.57	484.89	2	155-170	327.57	-	312.57
			gneiss	482.57	484.89	3	245-270	237.57	-	212.57
SRMW-1RC	EHC Road	OH	gneiss	481.74		NA	30-370	451.74	-	111.74
SRMW-2R	JCK Road	SCR	gneiss	358.29	361.34	NA	380-410	-21.71	-	-51.71
SRMW-2RA	JCK Road	SCR	gneiss	358.08	360.54	NA	240-260	118.08	-	98.08
SRMW-2S	JCK Road	SCR	sand & gravel	357.94	360.53	NA	50-70	307.94	-	287.94
SRMW-3R	SHN Road				285.89					
SRMW-4R	Blue Hill	Flute	dolostone	277.99	280.24	1	139-149	138.99	-	128.99
			dolostone	277.99	280.24	2	210-220	67.99	-	57.99
			dolostone	277.99	280.24	3	257-267	20.99	-	10.99
			dolostone	277.99	280.24	4	310-320	-32.01	-	-42.01
			shaley dolostone	277.99	280.24	5	371-381	-93.01	-	-103.01
			dolostone	277.99	280.24	6	423-433	-145.01	-	-155.01
SRMW-4S	Blue Hill	SCR	sand & gravel	278.08	279.79	NA	7.3-17.3	270.78	-	260.78
SRMW-5R	WEI Road	SCR	quartzite	319.11	320.63	NA	365-375	-45.89	-	-55.89
SRMW-5S	WEI Road	SCR	sand & gravel	319.48	322.33	NA	57-62	262.48	-	257.48
SRMW-6R	GRF Lane	SCR	shale / quartzite	335.96	337.58	NA	39-49	296.96	-	286.96
SRMW-7R	Patti Place	OH	quartzite	331.14	333.67	NA	109-302	222.14	-	29.14
SRMW-7S	Patti Place	SCR	silt, sand & gravel	332.3	333.83	NA	47-65	285.3	-	267.3
SRMW-8R	JCK Road	SCR	dolostone	368.12	370.29	NA	54-401	314.12	-	-32.88
SRMW-9R	JCK Road	OH	dolostone	376.26	378.38	NA	71.5-391	304.76	-	-14.74
SRMW-9S	JCK Road	SCR	gravel	375.76	377.44	NA	51.5-61.5	324.26	-	314.26
SRMW-10R	Prvt Rd/JCK	SCR	dolostone	356.6	358.63	NA	150-165	206.6	-	191.6
SRMW-10S	Prvt Rd /JCK	SCR	gravel	355.56	357.59	NA	66-76	289.56	-	279.56
SRMW-11S	TWN Road	SCR	sand & gravel	306.37	306.37	NA	12-22	294.37	-	284.37
SRMW-11R	TWN Road	Flute	dolostone	306.37	309.41	1	120-130	186.37	-	176.37
			dolostone	306.37	309.41	2	230-240	76.37	-	66.37
			quartzite	306.37	309.41	3	285-305	21.37	-	1.37
			quartzite	306.37	309.41	4	315-325	-8.63	-	-18.63
			quartzite	306.37	309.41	5	380-395	-73.63	-	-88.63
			dolostone	306.37	309.41	6	470-480	-163.63	-	-173.63
SRMW-12S	TWN Road	SCR	sand & gravel	297.56	297.56	NA	19-24	278.56	-	273.56
SRMW-12SA	TWN Road	SCR	sand & gravel	297.82	297.82	NA	34-49	263.82	-	248.82
SRMW-12SB	TWN Road	SCR	sand & gravel	298.22	298.22	NA	68-83	230.22	-	215.22
SRMW-12RA	TWN Road	SCR	dolostone	297.23	300.28	NA	250-260	47.23	-	37.23
SRMW-12RB	TWN Road	OH	dolostone	297.23	300.28	NA	118-179	179.23	-	118.23
SRMW-12RC	TWN Road	OH	dolostone	297.23	300.49	NA	270-320	27.23	-	-22.77
SRMW-12RD	TWN Road	SCR	dolostone	297.23	300.49	NA	388-398	-90.77	-	-100.77
SRMW-13S	OSH Road	SCR	gravel / S&G	331.05	331.05	NA	11-26	320.05	-	305.05
SRMW-13R	OSH Road	OH, Collapsed	dolostone	330.11	333.35	NA	154-500	176.11	-	-169.89
SRMW-14S	JCK & SHN	SCR	sand & gravel	349.07	349.07	NA	27-37	322.07	-	312.07
SRMW-14R	JCK & SHN	Flute	dolostone	348.97	351.37	1	150-170	198.97	-	178.97
				348.97	351.37	2	364-384	-15.03	-	-35.03
				348.97	351.37	3	430-440	-81.03	-	-91.03
				348.97	351.37	4	472-482	-123.03	-	-133.03
SRMW-14RA	JCK & SHN	SCR	weathered quartzite	348.18	350.81	NA	120-130	228.18	-	218.18
SRMW-14RB	JCK & SHN	OH	weathered quartzite	348.18	350.81	NA	90-110	258.18	-	238.18
SRMW-15S	CHURCH	SCR	Silt, S&G, gneiss	425.09	425.09	NA	48-58	377.09	-	367.09
SRMW-15R	CHURCH	Flute	gneiss	425.58	428.19	1	80-90	345.58	-	335.58
			gneiss	425.58	428.19	2	197-202	228.58	-	223.58
			gneiss	425.58	428.19	3	320-325	105.58	-	100.58
			gneiss	425.58	428.19	4	340-363	85.58	-	62.58
SRMW-16R	SCHOOL	Flute	gneiss	417.75	420.76	1	38-56	379.75	-	361.75
			gneiss	417.75	420.76	2	130-150	287.75	-	267.75
			gneiss	417.75	420.76	3	300-320	117.75	-	97.75
SRMW-17R	BRB Road	Flute	gneiss	384.01	384.01	1	43-60	341.01	-	324.01
			gneiss	384.01	384.01	2	87-97	297.01	-	287.01
			gneiss	384.01	384.01	3	139-149	245.01	-	235.01
			gneiss	384.01	384.01	4	163-173	221.01	-	211.01
			gneiss	384.01	384.01	5	230-250	154.01	-	134.01
			gneiss	384.01	384.01	6	312-322	72.01	-	62.01
			gneiss	384.01	384.01	7	413-423	-28.99	-	-38.99
SRMW-18RA	Facility	OH	gneiss	504.56	503.38	NA	45-80	459.56	-	424.56
SRMW-18RB	Facility	Flute	gneiss	504.28	504.28	1	115-125	389.28	-	379.28
			gneiss	504.28	504.28	2	140-150	364.28	-	354.28
SRMW-18RC	Facility	Flute	gneiss	504.46	504.46	1	205-215	299.46	-	289.46
			gneiss	504.46	504.46	2	220-235	284.46	-	269.46
SRMW-18RD	Facility	OH	gneiss	504.62	504.62	NA	247-320	257.62	-	184.62
SRMW-18RE	Facility	OH	gneiss	504.73	504.73	NA	40-275	464.73	-	229.73
SRMW-18RF	Facility	Flute	gneiss	505.03	505.03	1	420-440	85.03	-	65.03
			gneiss	505.03	505.03	2	485-500	20.03	-	5.03
SRMW-19R	SEY Lane	SCR	dolostone	322.69	322.69	NA	166-186	156.69	-	136.69
SRMW-19S*	SEY Lane	SCR	silt, sand & gravel	322.69	322.69	NA	25-30	297.69	-	292.69
SRMW-20R	WEI Road	OH	dolostn, qtzite& gneiss	341.96	345.51	NA	37.5-320	304.46	-	21.96
SRMW-20RA	WEI Road	OH	dolostn, qtzite& gneiss	342.11	345.33	NA	49-268	293.11	-	74.11

A-1b: SRMW- Locations Well Logs

GROUNDWATER SCIENCES CORPORATION

GEOLOGIC LOG: SRDW-1R

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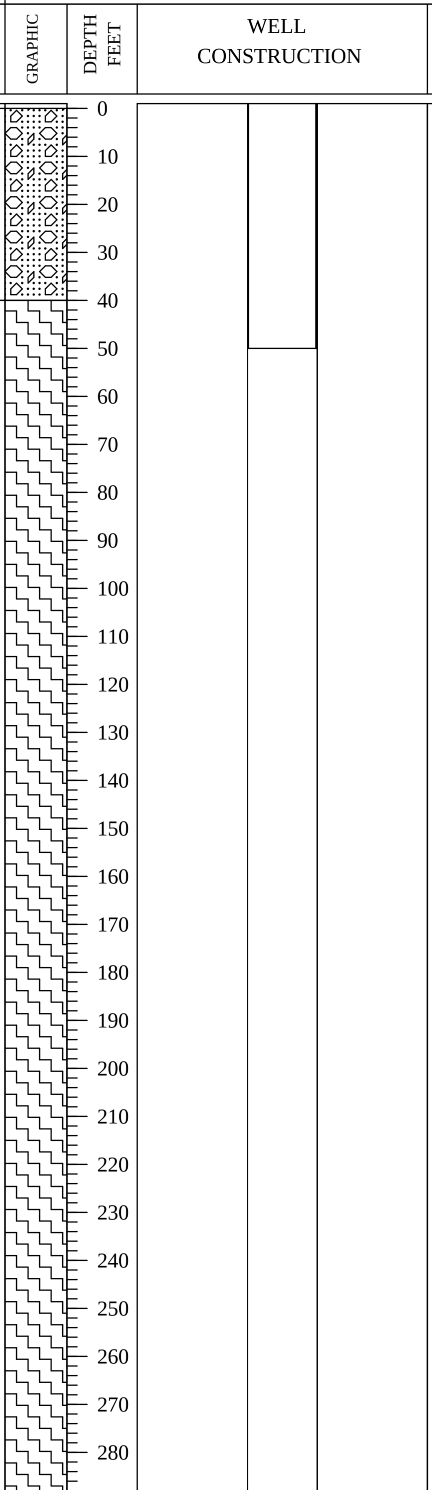
PROJECT INFORMATION		DRILLING INFORMATION	
PROJECT:	*IBM--Shenandoah Road Site*	DRILLING CO.:	*Eichelbergers Inc.*
SITE LOCATION:	*Shenandoah, Dutchess Co., NY*	DRILLER:	*Chris Brenneman*
JOB NO.:	*01003.11.0105*	RIG TYPE:	*Schramm*
LOGGED BY:	*S. Fisher*	DRILLING METHOD:	*Air Rotary*
DATES DRILLED:	---	DEVELOPMENT DATE:	---
		LOCATION:	*Zeller property, N. side of East Hook Cross Road*

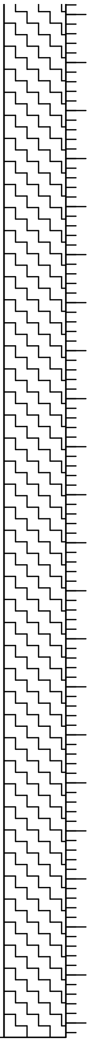
NOTES: Well was redeveloped to clear obstruction at 434 ft
Well redeveloped 9/25/01
TOC elevation: 421.61 ft amsl

ELEVATION: 420.52 ft amsl
NORTHING: 982694.469 EASTING: 685918.543

DEPTH FEET	CUM. BLOWN YIELD	SAMP. #	LITHOLOGY	WELL CONSTRUCTION DETAILS
0			SAND & GRAVEL	Locking well cap
10				
20				6" dia. steel casing, +1' to 50'
30				
40			GNEISS	
50				
60				
70				
80				
90				
100				6" dia. open borehole, 50' to 503'
110				
120				
130				
140				
150				
160				
170				
180				
190				
200				
210				
220				
230				
240				
250				
260				
270				
280				



GEOLOGIC LOG: SRDW-1R

DEPTH FEET	BLOWN YIELD (GPM)	SAMP. #	LITHOLOGY	GRAPHIC	DEPTH FEET	WELL CONSTRUCTION	WELL CONSTRUCTION DETAILS
290					290		
300					300		6" dia. open borehole, 50' to 503'
310					310		
320					320		
330					330		
340					340		
350					350		
360					360		
370					370		
380					380		
390					390		
400					400		
410					410		
420					420		
430					430		
440					440		
450					450		
460					460		
470					470		
480					480		
490					490		
500					500		

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GROUNDWATER SCIENCES CORPORATION

GEOLOGIC LOG: SRMW-1RA

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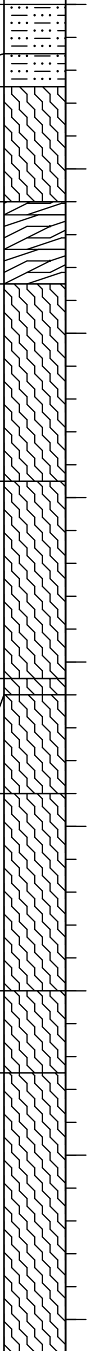
PROJECT INFORMATION		DRILLING INFORMATION	
PROJECT:	***IBM--Shenandoah Road Site***	DRILLING CO.:	***Eichelbergers Inc.***
SITE LOCATION:	***Shenandoah, Dutchess Co., NY***	DRILLER:	***Chris Brenneman***
JOB NO.:	***01003.11.0105***	RIG TYPE:	***Schramm***
LOGGED BY:	***S. Fisher***	DRILLING METHOD:	***Air Rotary***
DATES DRILLED:	***9/26/01 - 10/2/01***	DEVELOPMENT DATE:	***2/20/02***
		LOCATION:	***Heitmann property, north side of East Hook Cross Road***

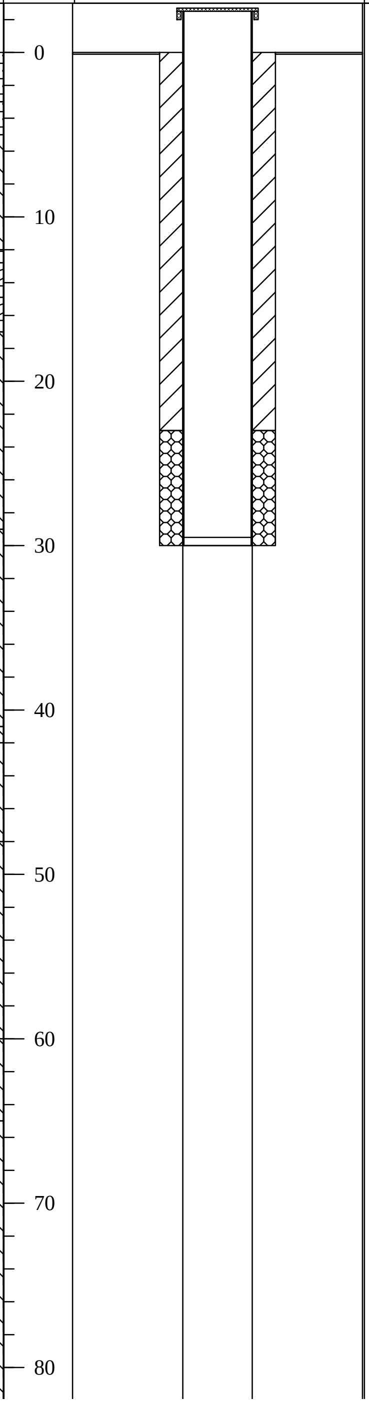
NOTES: SWL = 33.97 ft on 10/3/01
TOC elevation: 483.35 ft amsl
FLUTe system installed July 2006

SURFACE ELEVATION: 481.80 ft amsl

NORTHING: 982127.046 EASTING: 685450.800

DEPTH FEET	CUM. BLOWN YIELD	VOC (ppm)	LITHOLOGY	WELL CONSTRUCTION DETAILS
0			SILTY SAND: dk yellowish-brown (10YR4/2) w/ wthrd rock frags, rootlets throughout, dry to moist	
				6" locking well cap
			SILTY SAND: dk yellowish-orange (10YR6/6), moist	
			GNEISS: wthrd at top, becoming very competent, dk greenish gray (5GY4/1), quartze and biotite-rich, banded w/ light colored layers, some feldspar, occ. soft fracture zones	
				Bentonite slurry annular seal, 0' to 23'
10				
			FRACTURED GNEISS: softer, fractured zone 12'-17', w/ some brown silt and sand	
			GNEISS: banded, dk gray (N3) to olive gray (5Y4/1), w/ clear-white quartz, some pink quartz, biotite-rich, tr. pyrite, dry	6" dia. steel casing w/ driveshoe, +2.5' to 30'
20				
				Bentonite chip annular seal, 23' to 30'
30	0 gpm		GNEISS: w/ quartz and pink feldspar-rich zones, thin fracture at 37 ft	
40				
	0 gpm		GNEISS: dk greenish gray to dusky yellow green, w/ dk greenish-black biotite	
			GNEISS: predominantly quartz (60%) w/ dissementated biotite flakes	
			GNEISS: dk greenish gray to dusky yellowish green, biotite-rich zones, some pyrite	
50				6" dia. air rotary borehole, 30' to 462'
60			GNEISS: layered biotite, some white feldspar, tr. pyrite	
	0 gpm			
			GNEISS: banded, with biotite-rich zones	
70				
80				





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GROUNDWATER SCIENCES CORPORATION

GEOLOGIC LOG: SRMW-1RA

DEPTH FEET	BLOWN YIELD (GPM)	VOC (ppm)	LITHOLOGY	WELL CONSTRUCTION DETAILS
	0 gpm			
90				
			GNEISS: pink & white feldspar-rich, incr. pink feldspar w/ depth	
100			GNEISS: banded w/ biotite, pink feldspar and quartz-rich zones, softer interval 107'-111'	6" dia. air rotary borehole, 30' to 462'
	0 gpm			
110				
			GNEISS: banded, with biotite and quartz/feldspar-rich zones	
120				
	trace			
130				
			FRACTURED GNEISS: broken, pred. quartz w/ feldspar, tr. pyrite	
			GNEISS: biotite and feldspar-rich zones, occ. pink feldspar, occ. soft zone	
140				
	trace			
150			GNEISS: increase in white feldspar content, softer	
160				
	trace		GNEISS: biotite-rich zones, w/ little to no feldspar	
170				
			GNEISS: biotite-rich zones, occ. feldspar-quartz-rich zones	
180				
	trace			

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GROUNDWATER SCIENCES CORPORATION

GEOLOGIC LOG: SRMW-1RA

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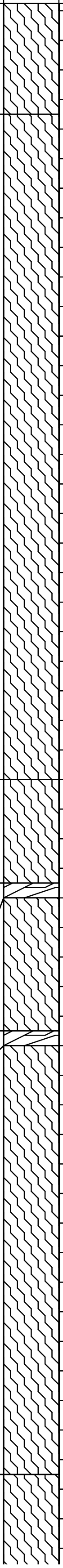

DEPTH FEET	BLOWN YIELD (GPM)	VOC (ppm)	LITHOLOGY	DEPTH FEET	WELL CONSTRUCTION	WELL CONSTRUCTION DETAILS
190				190		
			GNEISS: quartz-rich, pink & white feldspar-rich zones, occ. fractured zones			
200				200		6" dia. air rotary borehole, 30' to 462'
	trace					
210				210		
220				220		
	trace					
230				230		
240			GNEISS: biotite & qtz, some white feldspar	240		
	trace					
			FRACTURED GNEISS: fractured, some slickenslides, pyritic, some qtz., tr. iron staining, water-bearing			
250			GNEISS: lighter w/ disseminated biotite, tr. pink feldspar, some biotite-rich zones, soft zone at 258 ft	250		
			FRACTURED GNEISS: soft, broken, water-bearing			
260			GNEISS: v. competent, greenish gray w/ biotite, tr. pyrite, tr. pink feldspar	260		
	3 gpm					
270				270		
280				280		
	3 gpm					
			GNEISS: biotite-rich w/ some white feldspar, tr. pink feldspar, tr. white calcite @ 334'			
290				290		

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GROUNDWATER SCIENCES CORPORATION

GEOLOGIC LOG: **SRMW-1RA**

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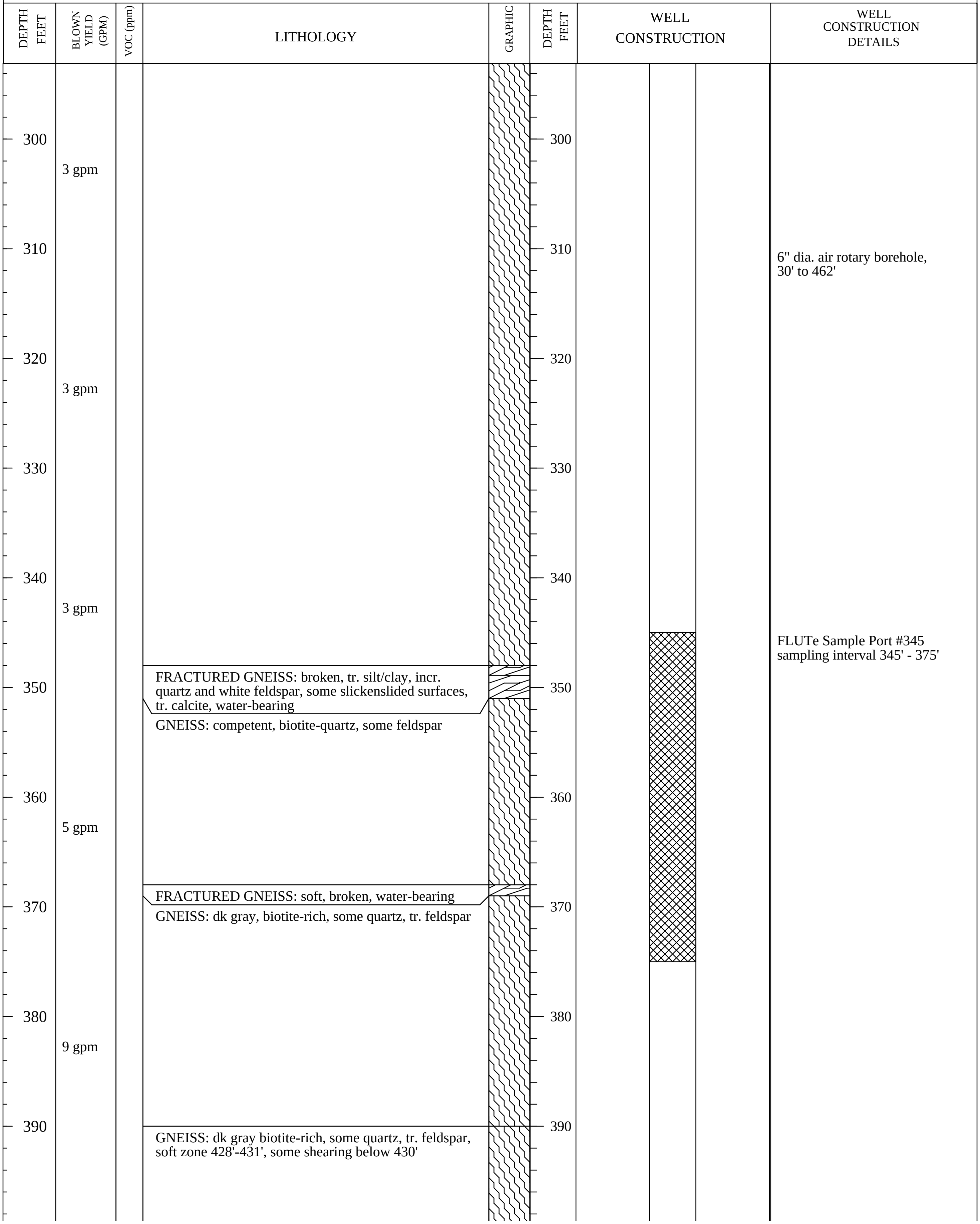

3 gpm

3 gpm

3 gpm

5 gpm

9 gpm

FRACTURED GNEISS: broken, tr. silt/clay, incr. quartz and white feldspar, some slickenslided surfaces, tr. calcite, water-bearing

GNEISS: competent, biotite-quartz, some feldspar

FRACTURED GNEISS: soft, broken, water-bearing

GNEISS: dk gray, biotite-rich, some quartz, tr. feldspar

GNEISS: dk gray biotite-rich, some quartz, tr. feldspar, soft zone 428'-431', some shearing below 430'

6" dia. air rotary borehole, 30' to 462'

FLUTe Sample Port #345 sampling interval 345' - 375'

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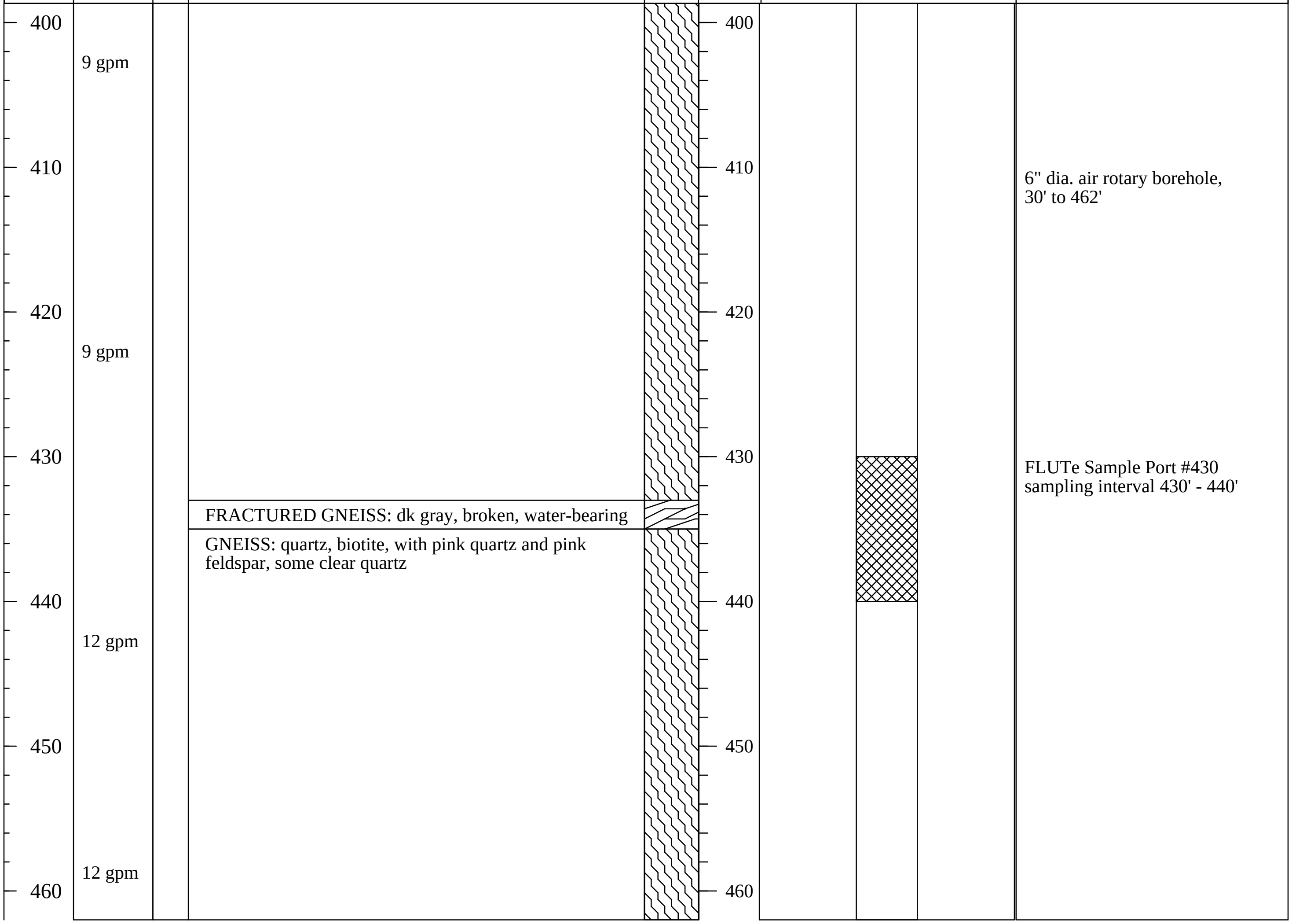
GROUNDWATER SCIENCES CORPORATION

GEOLOGIC LOG: SRMW-1RA



DEPTH FEET	BLOWN YIELD (GPM)	VOC (ppm)	LITHOLOGY	WELL CONSTRUCTION DETAILS
400				
	9 gpm			
410				6" dia. air rotary borehole, 30' to 462'
420				
	9 gpm			
430				FLUTe Sample Port #430 sampling interval 430' - 440'
			FRACTURED GNEISS: dk gray, broken, water-bearing	
			GNEISS: quartz, biotite, with pink quartz and pink feldspar, some clear quartz	
440				
	12 gpm			
450				
	12 gpm			
460				

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GROUNDWATER SCIENCES CORPORATION

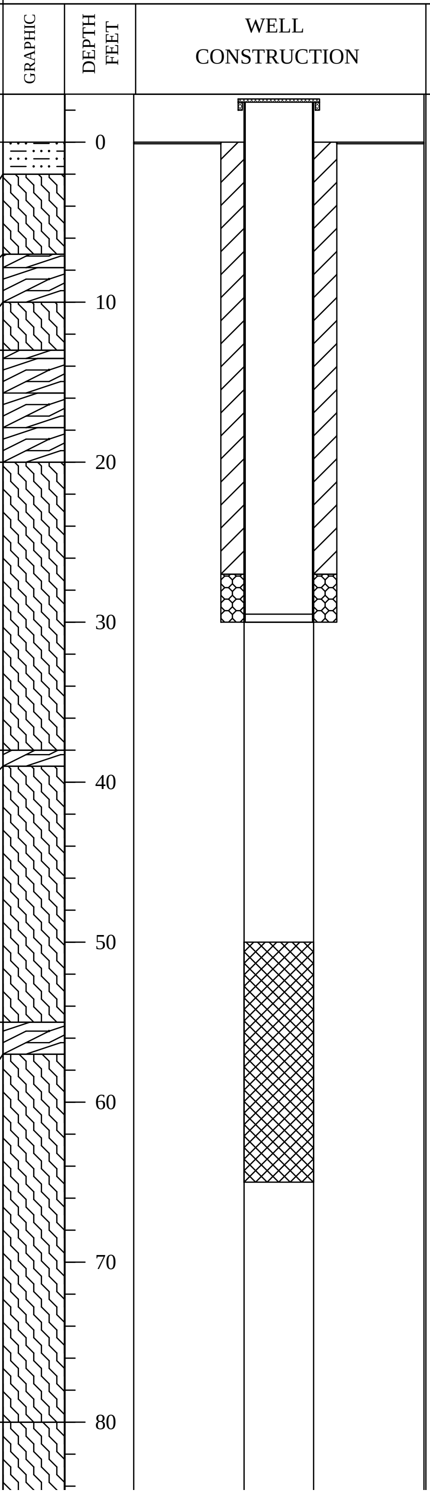
GEOLOGIC LOG: SRMW-1RB

PROJECT INFORMATION		DRILLING INFORMATION	
PROJECT:	***IBM--Shenandoah Road Site***	DRILLING CO.:	***Eichelbergers Inc.***
SITE LOCATION:	***Shenandoah, Dutchess Co., NY***	DRILLER:	***Jerry Books***
JOB NO.:	***01003.11.0105***	RIG TYPE:	***IR T2W***
LOGGED BY:	***S. Fisher***	DRILLING METHOD:	***Air Rotary***
		DEVELOPMENT DATE:	***2/22/02***
DATES DRILLED:	***12/13/01-12/17/01***	LOCATION:	***Heitmann property, approx. 10 ft SW of SRMW-1RA***

NOTES: SWL = 43.55 ft from TOC on 12/18/01
PID = 0 ppm; TOC elev: 484.89 ft amsl
FLUTe system installed in September 2006

SURFACE ELEVATION: 482.57 ft amsl
NORTHING: 982114.359 EASTING: 685450.662

DEPTH FEET	CUM. BLOWN YIELD	VOC (ppm)	LITHOLOGY
0			SILTY SAND: dk yellowish-brown (10YR4/2) w/ wthrd rock frags, rootlets throughout, dry to moist
			GNEISS: wthrd at top, turning competent, dk greenish gray (5GY4/1), quartz and biotite-rich, banded, some feldspar, occ. fractures
10			FRACTURED GNEISS: 7' to 10', broken, with iron-stained fractures
			GNEISS: biotite-rich with pink feldspar
			FRACTURED GNEISS: several broken intervals with iron-stained fractures, some silt, dry
20			GNEISS: biotite-rich w/ increasing quartz and feldspar, biotite disseminated in quartz below 30 ft
30	0 gpm		
			FRACTURED GNEISS: fractured at 38 ft
40	Trace		GNEISS: banded with zones rich in quartz and feldspar, pyritic below 50 ft
50			
			FRACTURED GNEISS: 55' to 57', broken, weathered, iron-stained fractures
60			GNEISS: dk greenish gray, biotite-rich, w/ quartz-rich zones and white feldspar, some hematite below 70'
	0.5 gpm		
70			
80			GNEISS: increasing biotite, pyritic, tr. wthrd feldspar
	0.5 gpm		



WELL CONSTRUCTION DETAILS

Locking well cap

Bentonite slurry annular seal, 0' to 27'

6" dia. steel casing w/ driveshoe, +2.5' to 30'

Bentonite chip annular seal, 27' to 30'

6" dia. air rotary borehole, 30' to 402'

FLUTe Sample Port #50 sampling interval 50' - 65'

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GROUNDWATER SCIENCES CORPORATION

GEOLOGIC LOG: **SRMW-1RB**

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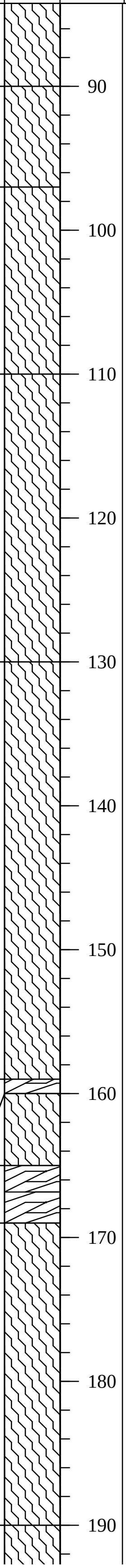
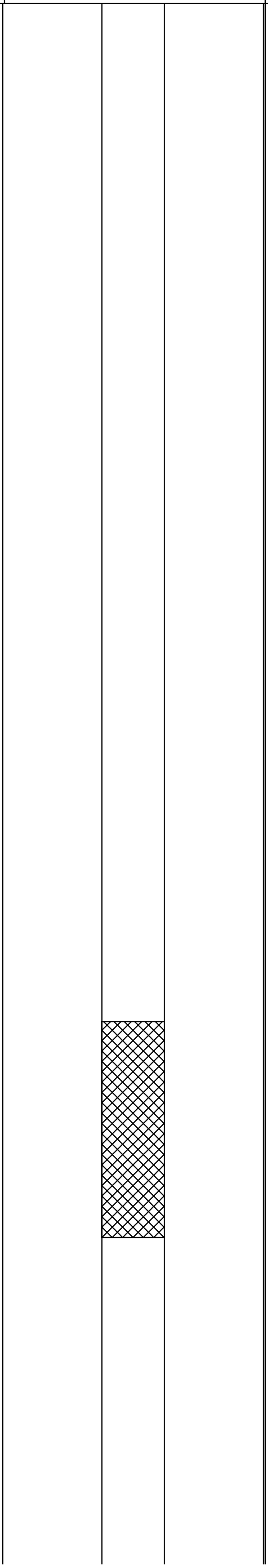
DEPTH FEET	BLOWN YIELD (GPM)	VOC (ppm)	LITHOLOGY	WELL CONSTRUCTION DETAILS
90			GNEISS: quartz-rich with disseminated biotite, tr. iron-staining	
			GNEISS: pred biotite and quartz, with felspar-rich zones, pyritic, fractured at 105'	
100	1 gpm			6" dia. air rotary borehole, 30' to 402'
110			GNEISS: dk greenish gray, pred. biotite with some qtz, tr. pink feldspar	
120	1 gpm			
130			GNEISS: dk greenish gray, with alternating zones rich in biotite, qtz, and feldspar, pyritic at 150'	
140	1 gpm			
150				FLUTe Sample Port #155 sampling interval 155' - 170'
160			FRACTURED GNEISS: 159' to 160', broken, sl. water-bearing	
	1.5 gpm		GNEISS: biotite-rich, pyritic	
			FRACTURED GNEISS: 165' to 169', broken	
170			GNEISS: biotite-rich, platy, some qtz and feldspar, tr. slickensides	
180	1.5 gpm			
190			GNEISS: pegmatitic, with pink feldspar and qtz, little	





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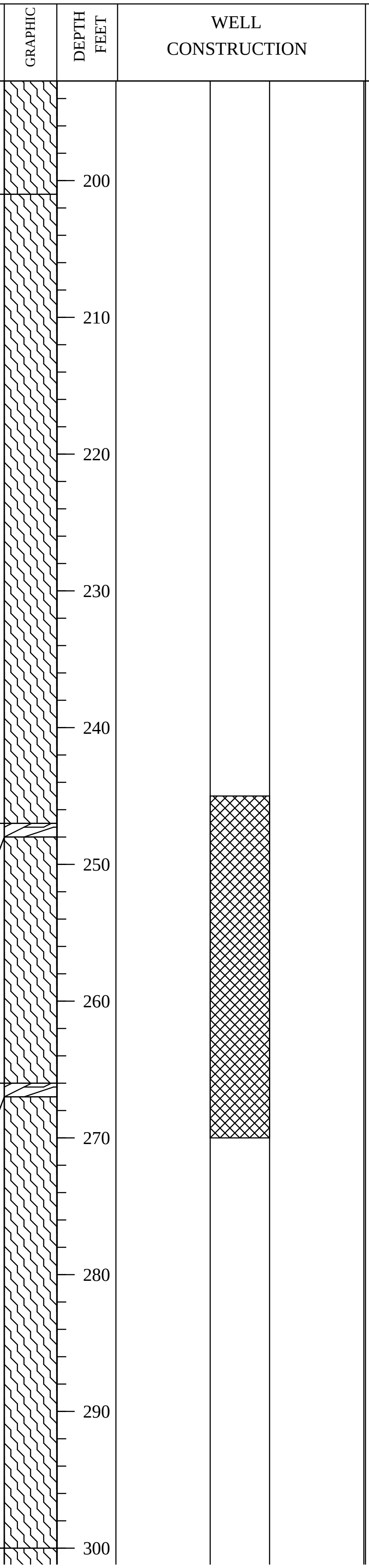
GROUNDWATER SCIENCES CORPORATION

GEOLOGIC LOG: SRMW-1RB

DEPTH FEET	BLOWN YIELD (GPM)	VOC (ppm)	LITHOLOGY	WELL CONSTRUCTION DETAILS
200				6" dia. air rotary borehole, 30' to 402'
	1.5 gpm		GNEISS: dk greenish gray, biotite-rich, with qtz, occ. pink feldspar layers, tr. pyrite	
210				
220				
	1.5 gpm			
230				
240				
	1.5 gpm			
				FLUTe Sample Port #245 sampling interval 245' - 270'
			FRACTURED GNEISS: 247' to 248', broken, water-bearing	
250			GNEISS: dk greenish gray, biotite-qtz, pred qtz below 260', pyritic	
260				
	6 gpm			
			FRACTURED GNEISS: 266' to 267', broken, water-bearing	
270			GNEISS: dk greenish gray, biotite-rich, incr. quartz content below 280'	
280				
	8 gpm			
290				
300				



Revised 12/7/07

GROUNDWATER SCIENCES CORPORATION

GEOLOGIC LOG: **SRMW-1RB**

DEPTH FEET	BLOWN YIELD (GPM)	VOC (ppm)	LITHOLOGY	DEPTH FEET	WELL CONSTRUCTION	WELL CONSTRUCTION DETAILS
	8 gpm					
310			GNEISS: quartz and white feldspar-rich zone, some biotite	310		6" dia. air rotary borehole, 30' to 402'
			GNEISS: dk greenish gray, biotite-rich			
320			GNEISS: coarse-grained mixture of biotite-qtz-feldspar, some hematite, tr. pyrite	320		
	8 gpm					
330			GNEISS: dk greenish gray, banded, incr. pyrite, occ. large mica masses	330		
340				340		
	8 gpm					
350			GNEISS: pred. white quartz, some biotite	350		
			GNEISS: dk greenish gray, pred. biotite, banded, with pyrite			
360				360		
	8 gpm					
370				370		
380				380		
	8 gpm					
390			FRACTURED GNEISS: 391' to 392', broken, water-bearing	390		
			GNEISS: dk greenish gray, pred. biotite, banded, with pyrite			
400	10 gpm			400		

GROUNDWATER SCIENCES CORPORATION

GEOLOGIC LOG: SRMW-1RC

Page 1 of 3

PROJECT INFORMATION

PROJECT: ***IBM--Shenandoah Road Site***
SITE LOCATION: ***Shenandoah, Dutchess Co., NY***
JOB NO.: ***01003.11.0105***
LOGGED BY: ***S. Fisher***
DATES DRILLED: ***12/18/01-12/19/01***

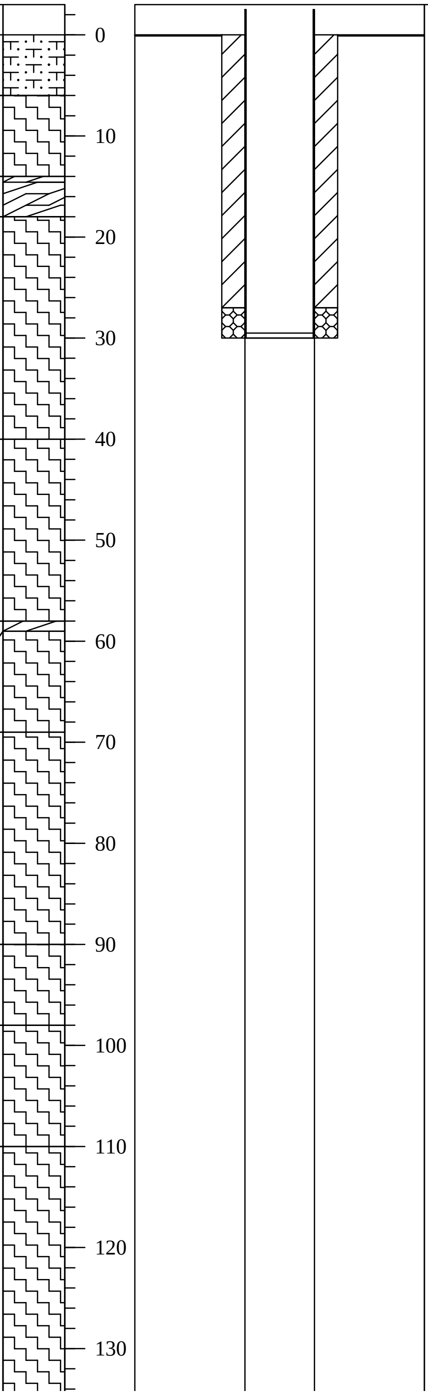
DRILLING INFORMATION

DRILLING CO.: ***Eichelbergers Inc.***
DRILLER: ***Jerry Books***
RIG TYPE: ***IR T2W***
DRILLING METHOD: ***Air Rotary***
DEVELOPMENT DATE: ***3/6/02***
LOCATION: ***Heitmann property, approx. 50 ft west of SRMW-1RA***

NOTES: SWL = 54.37' from TOC on 12/19/01
PID = 0 ppm; TOC elev.: 483.80 ft amsl
Main water-bearing zone at 353-357 ft

ELEVATION: 481.74 ft amsl
NORTHING: 982125.817 EASTING: 685394.906

DEPTH FEET	CUM. BLOWN YIELD	SAMP. #	LITHOLOGY	WELL CONSTRUCTION DETAILS
0			SILTY SAND: dk yellowish-brown (10YR4/2) w/ wthrd rock frags, rootlets throughout, dry to moist GNEISS: dk greenish gray (5 GY 4/1), banded, biotite-qtz-feldspar, tr pyrite, incr competency	Locking well cap Bentonite slurry annular seal, 0' to 27'
10			FRACTURED GNEISS: broken, soft GNEISS: dk greenish gray, banded, biotite-qtz, tr. iron staining	6" dia. steel casing w/ driveshoe, +2.5' to 30'
20				Bentonite chip annular seal, 27' to 30'
30				6" dia. open borehole, 30' to 370'
40	0 gpm		GNEISS: pred. white feldspar and quartz, some disseminated biotite, tr pink feldspar	
50			FRACTURED GNEISS: broken, tr iron-staining	
60	0 gpm		GNEISS: pred white feldspar and qtz, some biotite GNEISS: greenish black (5 GY 2/1) to dk greenish gray, biotite-rich, some qtz and feldspar	
70				
80	Trace			
90			GNEISS: increasing quartz, w/ disseminated biotite, occ. biotite-rich layers, w/ pyrite GNEISS: pink feldspar-rich zone, with white feldspar, quartz, some biotite	
100	Trace			
110			GNEISS: quartz-rich, with 40% biotite, some pyrite, increasing quartz and white feldspar and little biotite below 130'	
120	1 gpm			6" dia. open borehole, 30' to 370'
130				



DEPTH FEET	BLOWN YIELD (GPM)	SAMP. #	LITHOLOGY	GRAPHIC	DEPTH FEET	WELL CONSTRUCTION	WELL CONSTRUCTION DETAILS
140	2 gpm		FRACTURED GNEISS: soft, with weathered quartz, some pink feldspar		140		
			GNEISS: banded, with equvalent amounts of biotite and quartz, tr. iron-stained quartz				
150 160	2 gpm		GNEISS: biotite-rich, with pink feldspar, some wthrd white feldspar, tr. pyrite		150 160		6" dia. open borehole, 30' to 370'
170			GNEISS: very dark, nearly black, biotite-rich, some pink feldspar below 170'		170		
180	2 gpm		GNEISS: quartz and white feldspar-rich zone, some biotite-rich layers		180		
190 200	2 gpm		GNEISS: dark, biotite-rich, tr. quartz		190 200		
210			GNEISS: quartz and pink feldspar-rich, some biotite and pyrite, some white pyrite, tr. garnet		210		
220 230 240	2 gpm		GNEISS: dark, biotite-rich, some quartz and garnet, tr. feldspar		220 230 240		
250	2 gpm		GNEISS: quartz and white feldspar-rich, increasing feldspar below 248'		250		
260 270	3 gpm		GNEISS: dark, biotite-rich, some quartz and disseminated white feldspar, tr. pyrite		260 270		
280 290	3 gpm		GNEISS: increasing quartz and feldspar content to 295, then decreasing feldspar		280 290		
300	3 gpm		GNEISS: biotite and quartz, tr. pyrite, harder than above, tr. garnet, qtz-rich zone 309'-311'		300		

GEOLOGIC LOG: SRMW-1RC

DEPTH FEET	BLOWN YIELD (GPM)	SAMP. #	LITHOLOGY	GRAPHIC	DEPTH FEET	WELL CONSTRUCTION	WELL CONSTRUCTION DETAILS
310			GNEISS: dark greenish gray, biotite-rich		310		
320	3 gpm		QUARTZ: white quartz vein		320		6" dia. open borehole, 30' to 370'
330			GNEISS: mixture of biotite and quartz, some feldspar, sl. increase in qtz below 340'		330		
340	3 gpm				340		
350			FRACTURED GNEISS: 353' to 357', broken, water-bearing		350		
360	11 gpm		GNEISS: biotite and quartz, some feldspar		360		
370			GNEISS: pred. dk greenish gray, biotite-rich, some quartz		370		

Revised 9/12/07

GROUNDWATER SCIENCES CORPORATION

GEOLOGIC LOG: SRMW-2R

Page 1 of 3

PROJECT INFORMATION

PROJECT: ***IBM--Shenandoah Road Site***
SITE LOCATION: ***Shenandoah, Dutchess Co., NY***
JOB NO.: ***01003.11.0105***
LOGGED BY: ***S. Fisher/C.E. Stoner/K. Miller***
DATES DRILLED: ***10/3/01 - 10/10/01***

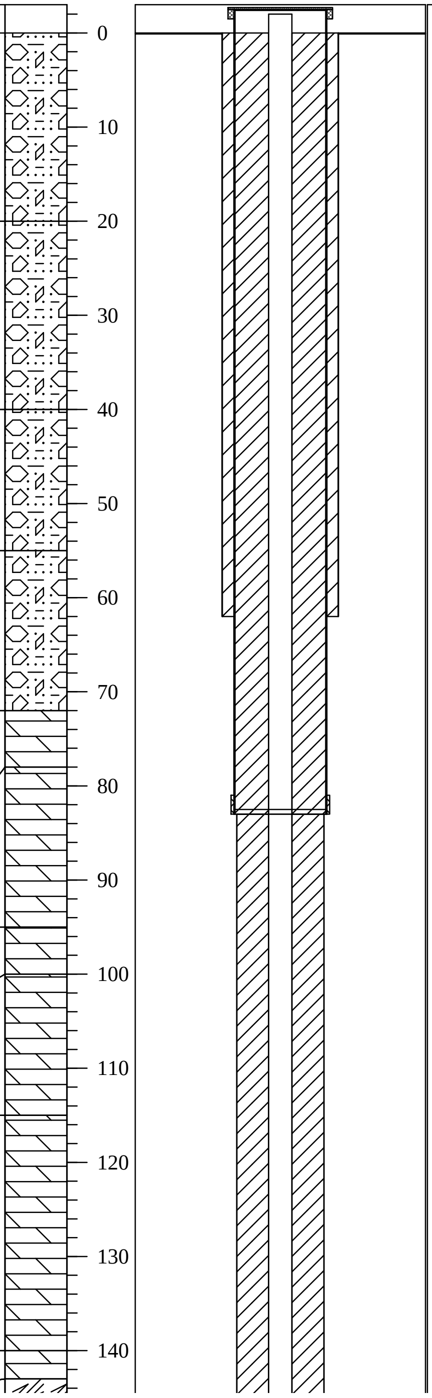
DRILLING INFORMATION

DRILLING CO.: ***Eichelbergers Inc.***
DRILLER: ***Chris Brenneman***
RIG TYPE: ***T450W***
DRILLING METHOD: ***Air Rotary***
DEVELOPMENT DATE: ***2/20/02***
LOCATION: ***N. side of Jackson Road next to woodline, E. of Shenandoah***

NOTES: PID = 0 ppm; TOC elev.: 361.34 ft amsl
SWL = 47.7' on 10/11/2001
2-inch piezometer installed July 27, 2006

SURFACE ELEVATION: 358.29 ft amsl
NORTHING: 983900.826 EASTING: 688014.659

DEPTH FEET	CUM. BLOWN YIELD	SAMP. #	LITHOLOGY
0			SILT, SAND & GRAVEL: dk yellow-brown, pred silt, vf-vc sand w/ some f SR-R gravel, cohesive to loose, moist to dry, roots in top 10'
10			
20			SILT, SAND & GRAVEL: as above, silty, moist below 20', occ. gravelly zones below 20', gravel composed of limestone w/ shale, quartzite, and sandstone of various colors (green, med. yellow), SA-SR/f-m tr. c pebbles
30			
40			SILT, SAND & GRAVEL: as above, very gravelly
50			SILT, SAND & GRAVEL: as above, wet below 55'
60			
70			DOLOSTONE: lt gray (N7), competent, little to no weathered material, occ. iron stained fracture surfaces
80			DOLOSTONE: as above w/ some v. lt gray (N8), iron stained fractures, dk gray (N3) limestone layers below 88', tr. pyritic laminations @ 90'
90			DOLOSTONE: med lt gray (N6), slightly mottled color w/ lt gray and med gray (N5), tr. calcite veining
100	0 gpm		DOLOSTONE: lt gray, competent, no weathered material
110			DOLOSTONE: lt to med gray, competent
120	0 gpm		
130			
140			DOLOSTONE: as above, w/ tr. calcite veining



WELL CONSTRUCTION DETAILS

Locking well cap

10" dia. borehole, 0' to 62'

Bentonite slurry 8x10 annular seal, 0' to 62'

Bentonite slurry 2x8 annular seal, 0' to 83'

2" dia. sch. 40 PVC riser, +2.5'-380'

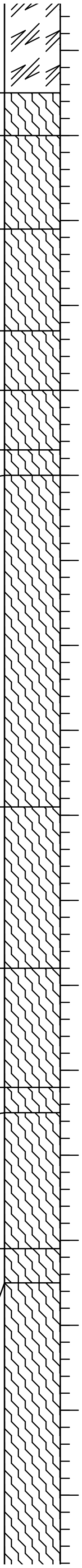
8" dia.steel casing with driveshoe, +2.5' to 83'

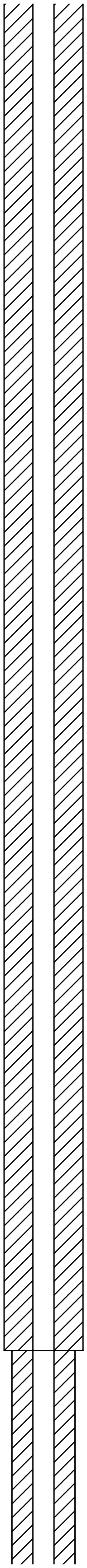
Bentonite chip annular seal, 81' to 83'

7.5" dia. air rotary borehole, 83' to 303'

Bentonite slurry 2x7.5 annular seal, 83' to 303'

2" dia. sch. 40 PVC riser, +2.5'-380'





DEPTH FEET	BLOWN YIELD (GPM)	SAMP. #	LITHOLOGY	WELL CONSTRUCTION DETAILS
	0 gpm		SHEARED GNEISS: soft zone at top, dusky green w/ some lighter zones of greenish gray quartzite, calcite veining, tr. pyritic laminations, mottling, appears sheared, competent	
150				
			GNEISS: as above, lighter greenish gray	
160				
	0 gpm		GNEISS: micaceous, darker zones, w/ quartz-rich zones	
170				7.5" dia. air rotary borehole, 83' to 303'
			GNEISS: greenish gray w/ dusky green , tr. grayish yellow green, mottled	
180				
	0 gpm		GNEISS: dusky green (5G3/2), competent, tr lighter greenish-gray zones	
190				
			GNEISS: soft layers of greenish gray and dusky green, possible fracture at 192'	
			GNEISS: tr. mod pink quartzite, tr. pyritic layering	
200				
	0 gpm		GNEISS: dusky green, tr. pink and light gray, tr. pyritic laminations, softer zone at 230', possible fracture at 236'	
210				
220				Bentonite slurry 2x7.5 annular seal, 83' to 303'
	0 gpm			
230				
240			GNEISS: dk gray layering	
	0 gpm			
250				
260			GNEISS: lt greenish gray (5GY8/1) to white/translucent, very hard, tr. grayish-pink	
	0 gpm			
270				2" dia. sch. 40 PVC riser, +2.5'-380'
			GNEISS: transition to dusky green	
			GNEISS: tr. pink quartz, tr. pyrite	
280				
	0.5 gpm			
290				
			GNEISS: greenish gray, tr. moderate reddish orange (10R6/6) quartz or feldspar, possible fracture zone at 294'	
300			GNEISS: dusky green, tr. pink, tr. pyrite at 315'	
	1 gpm			
310				6" dia. air rotary borehole, 303' to 503'
320				
	1.5 gpm			

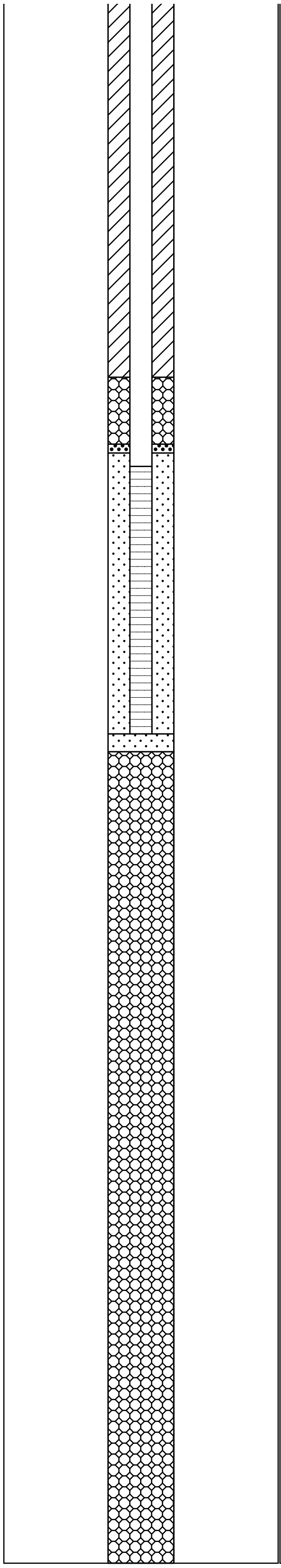
Revised 9/12/07

GROUNDWATER SCIENCES CORPORATION

GEOLOGIC LOG: SRMW-2R

DEPTH FEET	BLOWN YIELD (GPM)	SAMP. #	LITHOLOGY	WELL CONSTRUCTION DETAILS
330			GNEISS: dusky green w/ alternating white-translucent quartz-rich zones, tr. pyrite, soft zones at 340', 355', & 370'	
340	2 gpm			Bentonite slurry 2x6 annular seal, 303' to 370'
350				2" dia. sch. 40 PVC riser, +2.5'-380'
360	2 gpm			
370			GNEISS: grayish pink quartz, lighter coloration	Bentonite chip 2x6 annular seal, 370'-377.5' #1 grade choke sand, 377.5'-378.5'
380	2 gpm		GNEISS: dusky green and lt grayish green, with biotite, tr. pyrite	
390				#2 grade sand pack, 378.5'-412'
400	3 gpm		GNEISS: dusky green to lt grayish green	2" dia. 20-slot PVC screen, 380'-410'
410				
420	5 gpm		GNEISS: soft zone GNEISS: dusky green, lt olive gray, white-translucent, fused crystals	
430				
440	5 gpm			6" dia. air rotary borehole, 303' to 503'
450				
460	5 gpm			
470			GNEISS: v dk olive-black, tr. translucent quartzite GNEISS: dusky green, lt olive gray, white-translucent, some pink	Bentonite chip backfill, 412'-503'
480	5 gpm			
490	5 gpm		GNEISS: dk olive black, w/ incr. white/translucent quartz, biotite	
500				

WELL CONSTRUCTION



GROUNDWATER SCIENCES CORPORATION

GEOLOGIC LOG: SRMW-2RA

Page 1 of 3

PROJECT INFORMATION

PROJECT: ***IBM--Shenandoah Road Site***

SITE LOCATION: ***Shenandoah, Dutchess Co., NY***

JOB NO.: ***01003.11.0105***

LOGGED BY: ***B. Titone***

DATES DRILLED: ***7/18/06 - 7/20/06***

DRILLING INFORMATION

DRILLING CO.: ***Eichelbergers Inc.***

DRILLER: ***C. Knaub***

RIG TYPE: ***IR T4W***

DRILLING METHOD: ***Air Rotary***

DEVELOPMENT DATE: ***NA***

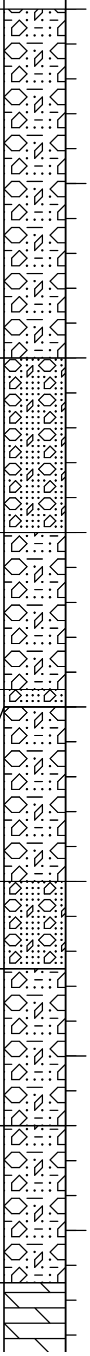
LOCATION: ***N. side of Jackson Road, adjacent to SRMW-2R***

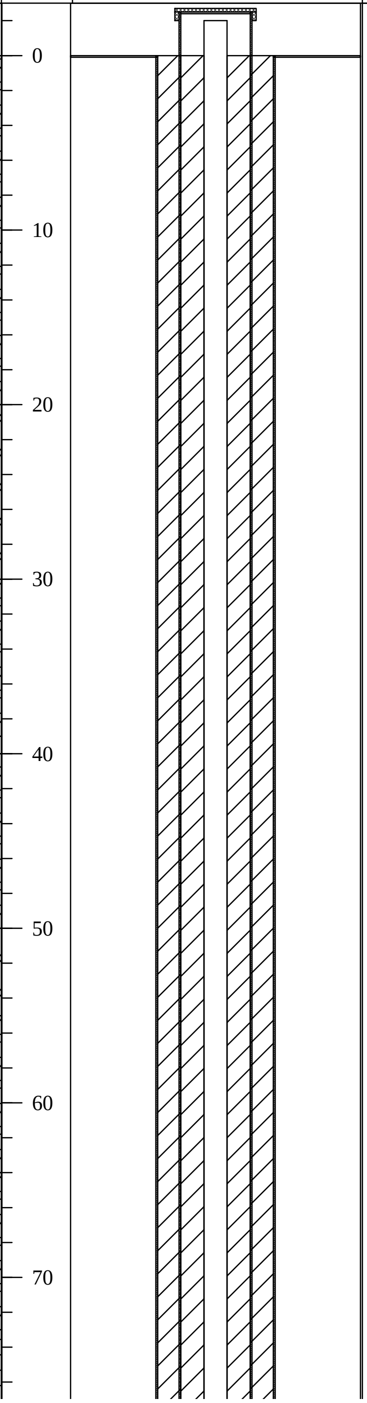
NOTES: TOC elev.: 359.92 ft amsl
SWL = 31.33' on 7/27/06
2-inch piezometer installed July 27, 2006

SURFACE ELEVATION: 358.08 ft amsl

NORTHING: 983913.29 EASTING: 687994.92

DEPTH FEET	CUM. BLOWN YIELD	VOC (ppm)	LITHOLOGY
0			SILT, SAND & GRAVEL: mod yellowish brown (10 YR 5/4) vf-vc sand, some f-c SR-R gravel, organic at top, roots top 10 feet, cohesive, moist
20			SAND & GRAVEL: pred vc sand, SR-R, various lithologies and colors, f-c gravel present
30			SILT, SAND & GRAVEL: mod yellowish brown, A-SA gravel, some SR, various liths, vf to vc with silt and tr m-c sand, occ sandy zones with m sand, and minor vf sand
40			SAND & GRAVEL: vf gravel, vc sand, various liths, w/ silt tr fine sand
			SILT, SAND & GRAVEL: as above, some finer gravelly zones and some vc-c sandy zones, water-bearing zones
50			SAND & GRAVEL: as above, cobbly zone w/ vc gravel
			SILT, SAND & GRAVEL: as above, color changes to lt olive gray (5 Y 5/2), vc sand, granules and f gravel, A-SA, some SR
60			
			SILT, SAND & GRAVEL: as above, cobbles to granules, w/ vc sand, tr f sand and some silt, lt olive gray, occ SR gravel, various lithologies
70			
			DOLOSTONE: med gray (N5) to lt gray (N7) A-SA frags w/ gravel at top, hard occ grayish black (N2) pieces, still some gravel, tr cherty frags





WELL CONSTRUCTION DETAILS

Locking well cap

10" dia. STRADEX steel casing w/ drive shoe, 0' to 85'

Bentonite slurry 6x10 annular seal, 0' to 83'

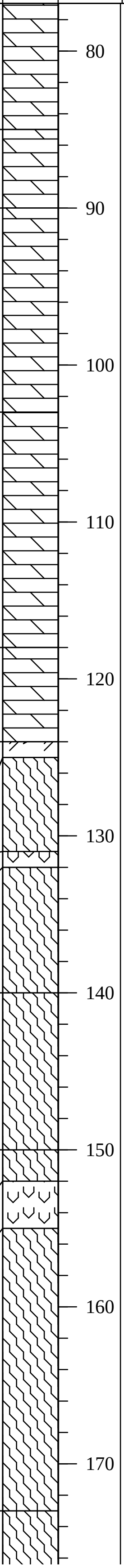
6 " dia. steel casing w/ drive shoe, 2.5' to 87'

Bentonite slurry 2x6 annular seal, 0' to 227'

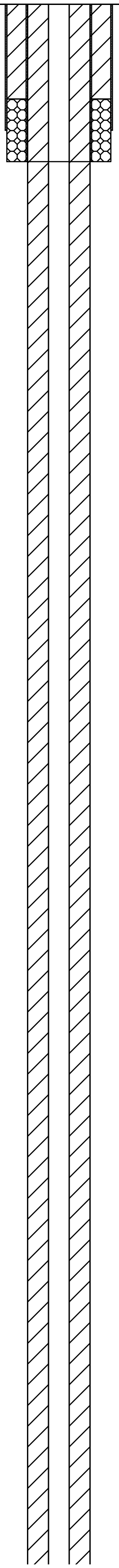
2" dia. sch. 40 PVC riser, +2.0'-240'

DEPTH FEET	BLOWN YIELD (GPM)	VOC (ppm)	LITHOLOGY
80			
	0 gpm		DOLOSTONE: very light gray (N8) to medium gray (N5), occasional dark gray (N3) color
90			DOLOSTONE: medium gray, hard
100			DOLOSTONE: medium gray, trace of pyrite bands
110			
120			DOLOSTONE: medium gray, thin layers of light gray
	0 gpm		SHEARED DOLOSTONE: sheared dolostone and rock flour
130			GNEISS: greenish black (5 G 2/1) with minor med light gray (N6) qtz banding, foliated, phyllitic sheen, tr pyrite, some dk greenish gray (5 GY 4/1) gneiss
			QUARTZ: dusky yellow green (5 GY 5/2)
			GNEISS: greenish black (5 G 2/1) to grayish black (N2) with dark greenish gray (5 GY 4/1) to dusky yellow green (5 GY 5/2) qtz veins, micaceous, phyllitic, sl foliation
140			GNEISS: as above, less quartz
150	0 gpm		GNEISS: greenish gray (5 GY 6/1) to med lt gray (N6) quartz banding
			QUARTZ: greenish gray, massive, w/ black gneiss specks
160			GNEISS: greenish black, with light gray quartz banding, some massive qtz, tr pyrite, pale olive (10 Y 6/2) qtz veins at 162' and 168'
170			
	0 gpm		GNEISS: greenish black, micaceous, foliated, shiny, schistose texture, tr pyrite, speckled throughout

GRAPHIC



WELL CONSTRUCTION



WELL CONSTRUCTION DETAILS

10" dia. STRADEX steel casing w/ drive shoe, 0' to 85'

Bentonite slurry 6x10 annular seal, 0' to 83'

6 " dia. steel casing w/ drive shoe, 2.5' to 87'

Bentonite chip 6x10 annular seal, 83' to 87'

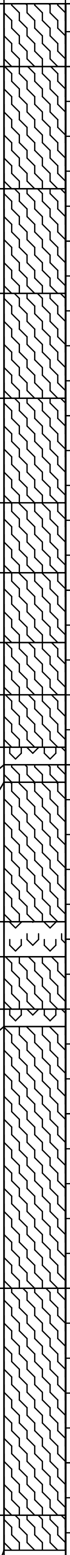
6" dia. air rotary borehole, 87' to 265'

Bentonite slurry 2x6 annular seal, 0' to 227'

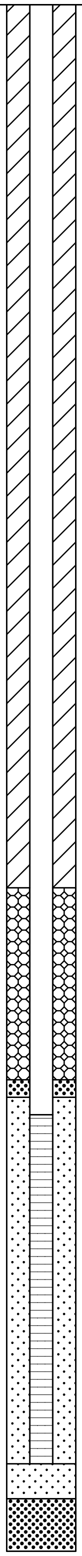
2" dia. sch. 40 PVC riser, +2.0'-240'

DEPTH FEET	BLOWN YIELD (GPM)	VOC (ppm)	LITHOLOGY
180			GNEISS: as above, no pyrite
190			GNEISS: dk greenish gray high quartz content, massive, competent, little to no mica
			GNEISS: dk greenish gray w/ lt gray quartz banding and black linear specks
200	0 gpm		GNEISS: greenish black foliations, possible chlorite, pyrite specks common
			GNEISS: dk greenish gray quartz-rich, massive, trace pink quartz
210			GNEISS: greenish black, foliated, slight schistose texture
			GNEISS: dk greenish gray, massive, quartz-rich, slight foliations
			GNEISS: as above, more foliation
220			QUARTZ: pale olive quartz vein
			GNEISS: as above, high quartz content
	0 gpm		GNEISS: as above, some pale red (5 R 6/2) quartz vein
230			QUARTZ: pale olive quartz vein
			GNEISS: greenish black, slightly foliated, micaceous, with pyrite
			QUARTZ: pale olive quartz vein
240			GNEISS: med bluish gray (5 B 5/1) to greenish black (5 G 2/1) quartz rich, tr grayish orange pink (5 YR 7/2) quartz, tr pyrite
250 260	<10 gpm		GNEISS: sl silvery , dk greenish gray (5 GY 4/1) w/ quartz, tr pink quartz, tr dk greenish yellow (10 Y 6/6) mineral, some quartz, quartz vein at 254', sl foliation, quartz vein at 260'
	<10 gpm		GNEISS: dk greenish gray (5 G 4/1) quartz rich, dk speckled bands of mica, lit to no foliation, tr yellow mineral, tr pink quartz, tr pyrite
270			

GRAPHIC



WELL CONSTRUCTION



WELL CONSTRUCTION DETAILS

6" dia. air rotary borehole, 87' to 265'

Bentonite slurry 2x6 annular seal, 0' to 227'

2" dia. sch. 40 PVC riser, +2.0'-240'

Bentonite chip 2x6 annular seal, 227'-238'

#1 grade choke sand, 238'-239'

#2 grade sand pack, 239'-262'

2" dia. 20-slot PVC screen, 240'-260'

#1 grade choke sand, 262'-265'

GROUNDWATER SCIENCES CORPORATION

GEOLOGIC LOG: SRMW-2S

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PROJECT INFORMATION

PROJECT: ***IBM--Shenandoah Road Site***

SITE LOCATION: ***Shenandoah, Dutchess Co., NY***

JOB NO.: ***01003.11.0105***

LOGGED BY: ***K. Miller***

DATES DRILLED: ***10/11/01***

DRILLING INFORMATION

DRILLING CO.: ***Eichelbergers Inc.***

DRILLER: ***Chris Brenneman***

RIG TYPE: ***Schramm***

DRILLING METHOD: ***Air Rotary***

DEVELOPMENT DATE: ***2/28/02***

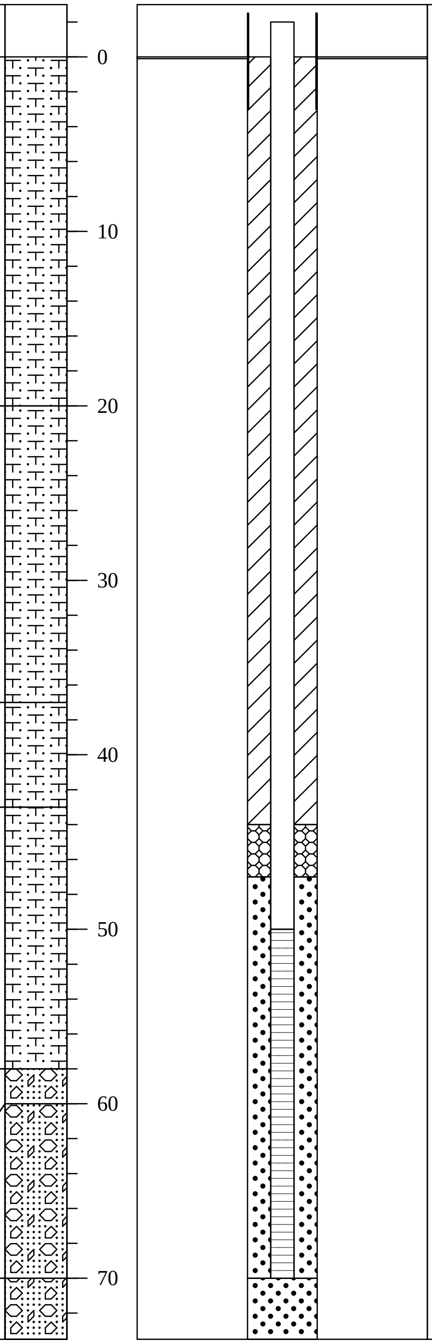
LOCATION: ***N. side of Jackson Road, 10 ft E. of SRMW-2R***

NOTES: PID = 0 ppm
TOC elev.: 360.53 ft amsl

ELEVATION: 357.94 ft amsl

NORTHING: 983906.768 EASTING: 688003.666

DEPTH FEET	CUM. BLOWN YIELD	SAMP. #	LITHOLOGY
0			SILTY SAND: dk yellow-brown, gravelly, cohesive to loose, moist to dry, roots in top 10'
20	0 gpm		SILTY SAND: med brown, inc. cohesive, moist, occasional small gravel zones
37	0 gpm		SILTY SAND: dk yellow brown to med brown, f-m, tr. c gravel
43			SILTY SAND: lt to med brown, occasional subangular gravel
58			SAND & GRAVEL: SAA, f-m, tr. gravel composed of olive-gr quartzite & lt gayish-blue dolostone
60	0 gpm		SAND & GRAVEL: lt brown-gr, gravel composed of c lt bluish-gray dolostone and tr. quartzite
70			SAND & GRAVEL: yellow-brown, dolostone bedrock at 73.5 feet



WELL CONSTRUCTION DETAILS

6" dia. steel standpipe w/ locking cap

Sch. 40 PVC riser pipe, +2.5' to 50'

6" dia. borehole, 0' to 73.5'

Bentonite slurry annular seal, 0' to 44'

Bentonite pellet annular seal, 44' to 47'

10-slot PVC screen, 50' to 70'

#00 Sand, 47' to 73.5'

2" bottom cap

Revised 12/7/07

GROUNDWATER SCIENCES CORPORATION

GEOLOGIC LOG: SRMW-4R

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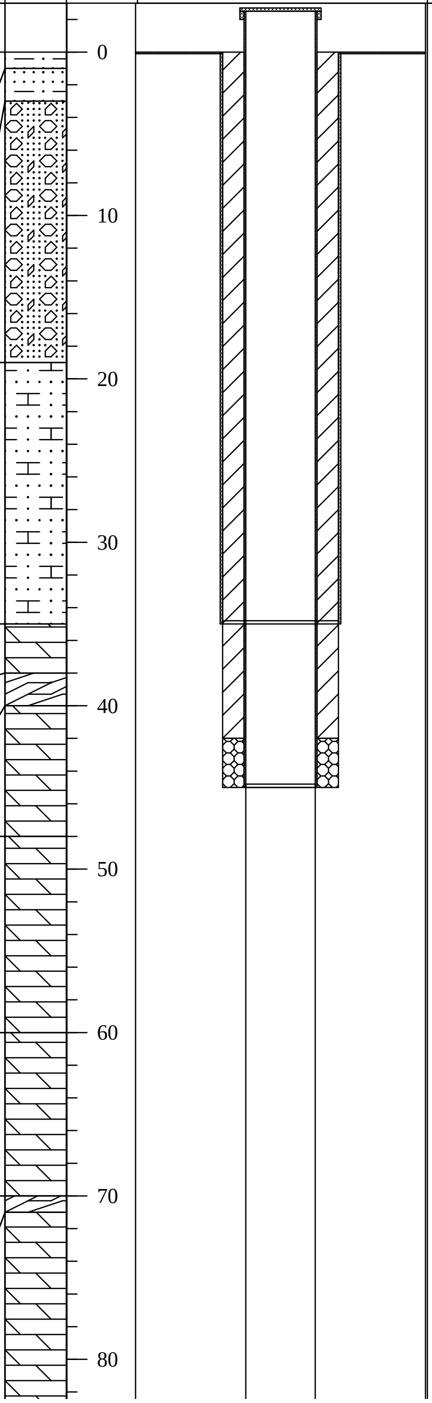
PROJECT INFORMATION		DRILLING INFORMATION	
PROJECT:	***Shenandoah Road Site***	DRILLING CO.:	***Eichelbergers Inc.***
SITE LOCATION:	***Shenandoah, Dutchess Co., NY***	DRILLER:	***J. Books***
JOB NO.:	***01003.11.0105***	RIG TYPE:	***IR T2W***
LOGGED BY:	***S. Fisher***	DRILLING METHOD:	***Air Rotary***
DATES DRILLED:	***1/15/02-1/16/02***	DEVELOPMENT DATE:	***2/21/02***
		LOCATION:	***On western edge of Domenic property, in woods***

NOTES: Large volume of water cased off at 40 ft, incompetent rock
SWL = 6.62' below TOC 1/17/02; TOC elev. 280.24 ft amsl
FLUTe system installed October 2007

SURFACE ELEVATION: 277.99 ft amsl
NORTHING: 986894.328 EASTING: 685608.492

DEPTH FEET	CUM. BLOWN YIELD	VOC (ppm)	LITHOLOGY
0			SAND & SILT: dk brown, pred silt, organic, w/ roots and wood fragments, moist
			SAND & SILT: lt olive gray and dk yellowish orange, mottled, vf-f sand, some m-c, tr. f-m SR-R gravel, tr. rootlets
10			SAND & GRAVEL: dk yellowish brown, some silt, vf-vc sand and f-m SR-R gravel, occ. c gravel, loose, moist to wet, saturated below 8 ft
20 30			CLAY & SILT: lt olive gray,some vf-f sand, tr. fine gravel, wet
			DOLOSTONE: dk gray (N3), w/ iron-stained fractures, some calcite veining
40	50 gpm		FRACTURED DOLOSTONE: 38'-40', broken, some weathered material, water bearing
			DOLOSTONE: med. gray to dk gray, tr. pyrite, some iron-stained fractures
50			DOLOSTONE: dk gray, trace of calcite veining, tr. pyrite
60	Trace		DOLOSTONE: dk gray (N3) to grayish black (N2), finely crystalline, tr. pyrite and calcite
70			FRACTURED DOLOSTONE: 70'-71', dk gray, w/ abundant calcite veining, slickensided
80			DOLOSTONE: dk gray, tr. pyrite and calcite, competent



WELL CONSTRUCTION DETAILS

6" locking well cap

10" dia. steel casing with driveshoe, 0' to 35'

6" dia.steel casing with driveshoe, +2.5' to 45'

Bentonite slurry 10"x6" annular seal, 0' to 42'

Bentonite chip 10"x6" annular seal, 42' to 45'

6" dia. air rotary borehole, 45' to 502'

Revised 12/7/07

GROUNDWATER SCIENCES CORPORATION

GEOLOGIC LOG: SRMW-4R

DEPTH FEET	BLOWN YIELD (GPM)	VOC (ppm)	LITHOLOGY	DEPTH FEET	WELL CONSTRUCTION DETAILS
	0.5 gpm				
			DOLOSTONE: dk gray, shaly texture, with pyrite		
90				90	
100	0.5 gpm			100	6" dia. air rotary borehole, 45' to 502'
			DOLOMITIC LIMESTONE: dk gray to blackish gray, tr. pyrite, some calcite		
110				110	
			DOLOSTONE: med dk gray, w/ pyrite and calcite		
120	0.5 gpm			120	
			DOLOSTONE: mixed med gray and white, w/ abundant calcite veining		
130				130	
			DOLOSTONE: white, grading to v. lt gray, high purity, no pyrite		
140	<1 gpm			140	FLUTE Sample Port # 139 sampling interval 139' - 149'
150				150	
			DOLOSTONE: mixture of med lt gray and lt olive gray, with calcite veining		
160	<1 gpm			160	
170				170	
			DOLOSTONE: olive black to lt olive gray, with pyrite		
180	<1 gpm			180	

Revised 12/7/07

GROUNDWATER SCIENCES CORPORATION

GEOLOGIC LOG: SRMW-4R

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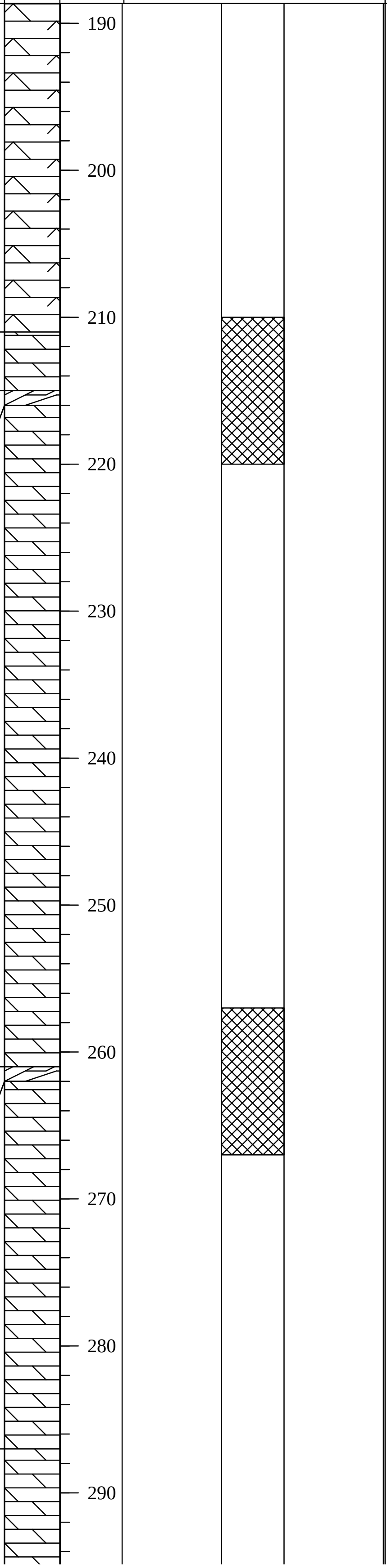
DEPTH FEET	BLOWN YIELD (GPM)	VOC (ppm)	LITHOLOGY	WELL CONSTRUCTION DETAILS
190			CALCAREOUS DOLOSTONE: dk gray, graphitic, tr. pyrite and calcite, homogeneous	
				6" dia. air rotary borehole, 45' to 502'
200				
	1 gpm			
210				FLUTE Sample Port # 210 sampling interval 210' - 220'
			DOLOSTONE: med lt gray to lt olive gray	
			FRACTURED DOLOSTONE: 215'-216', broken, tr. iron-stained fractures, water-bearing	
			DOLOSTONE: dk gray, tr. calcite, occ. pyrite-rich zones	
220				
	2 gpm			
230				
240				
	2 gpm			
250				
				FLUTE Sample Port # 257 sampling interval 257' - 267'
260				
	3 gpm		FRACTURED DOLOSTONE: 261'-262', broken, water-bearing	
			DOLOSTONE: dk gray, tr. calcite, some pyrite	
270				
280				
	4 gpm			
			DOLOSTONE: dk gray, homogeneous, tr. calcite	
290				

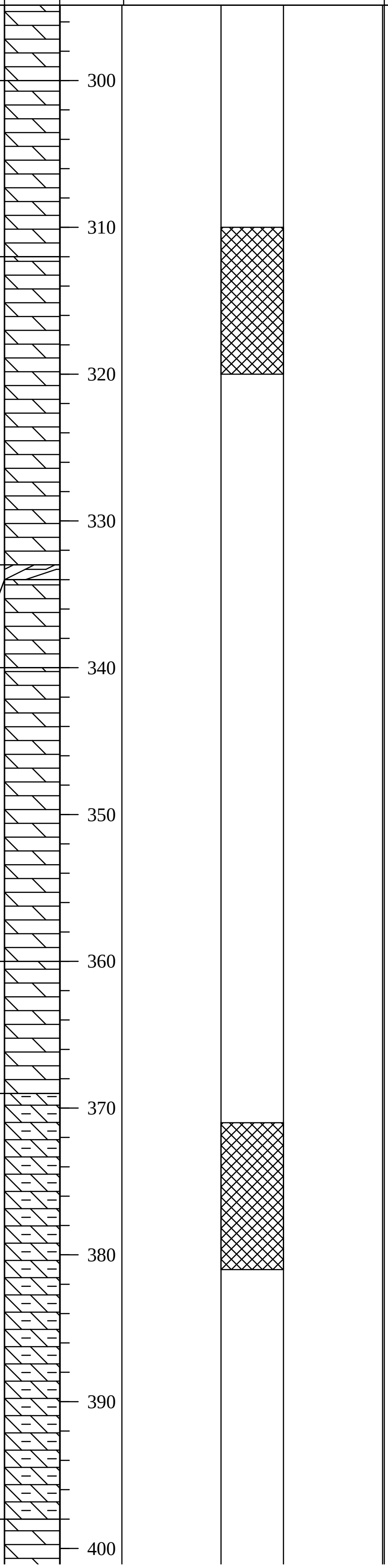


Revised 12/7/07

GROUNDWATER SCIENCES CORPORATION

GEOLOGIC LOG: SRMW-4R

DEPTH FEET	BLOWN YIELD (GPM)	VOC (ppm)	LITHOLOGY	WELL CONSTRUCTION DETAILS
300	5 gpm		DOLOSTONE: dk gray, some lt olive gray, shaly, pyritic, slickensided	
310				FLUTE Sample Port # 310 sampling interval 310' - 320'
			DOLOSTONE: med gray to lt olive gray, shaly and massive, tr. iron-stained fractures, tr. pyrite and calcite	
320	7 gpm			
330			FRACTURED DOLOSTONE: 333'-334', broken, water-bearing	
			DOLOSTONE: med gray to v. lt gray w/ calcite	
340	8 gpm		DOLOSTONE: lt gray to lt olive gray, w/ calcite, some shaly texture, occ. pyritic laminations	6" dia. air rotary borehole, 45' to 502'
350				
360	8 gpm		DOLOSTONE: lt gray, coarse crystalline, some pyrite	
370			SHALY DOLOSTONE: interlayered lt gray to dk greenish gray dolostone with dk gray shale, pyritic, tr. calcite	FLUTE Sample Port # 371 sampling interval 371' - 381'
380	8 gpm			
390				
400			DOLOSTONE: dk gray, some lt olive gray shaly zones, tr. calcite	



Revised 12/7/07

GROUNDWATER SCIENCES CORPORATION

GEOLOGIC LOG: SRMW-4R

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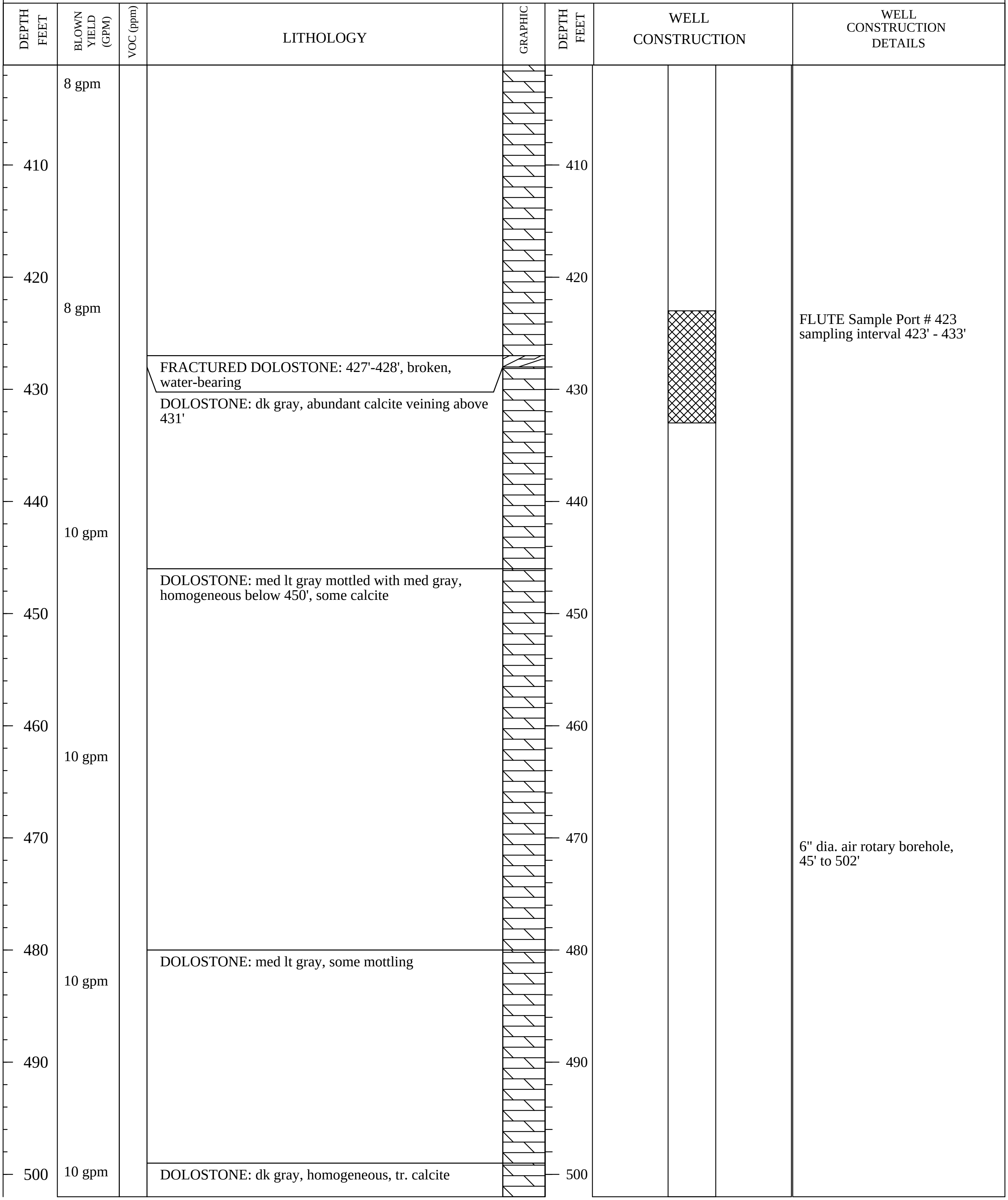


DEPTH FEET	BLOWN YIELD (GPM)	VOC (ppm)	LITHOLOGY	DEPTH FEET	WELL CONSTRUCTION DETAILS
	8 gpm				
410				410	
420				420	
	8 gpm				FLUTE Sample Port # 423 sampling interval 423' - 433'
			FRACTURED DOLOSTONE: 427'-428', broken, water-bearing		
			DOLOSTONE: dk gray, abundant calcite veining above 431'		
430				430	
440				440	
	10 gpm				
			DOLOSTONE: med lt gray mottled with med gray, homogeneous below 450', some calcite		
450				450	
460				460	
	10 gpm				
470				470	6" dia. air rotary borehole, 45' to 502'
480			DOLOSTONE: med lt gray, some mottling	480	
	10 gpm				
490				490	
500	10 gpm		DOLOSTONE: dk gray, homogeneous, tr. calcite	500	

GROUNDWATER SCIENCES CORPORATION

GEOLOGIC LOG: SRMW-4S

Page 1 of 1

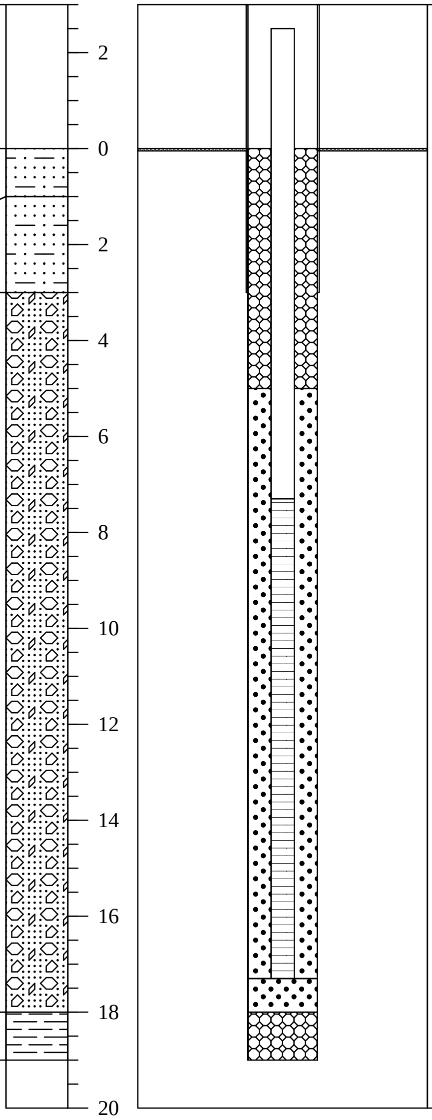
PROJECT INFORMATION		DRILLING INFORMATION	
PROJECT:	***Shenandoah Road Site***	DRILLING CO.:	***Eichelbergers Inc.***
SITE LOCATION:	***Shenandoah, Dutchess Co., NY***	DRILLER:	***Jerry Books***
JOB NO.:	***01003.11.0105***	RIG TYPE:	***IR T2W***
LOGGED BY:	***S. Fisher***	DRILLING METHOD:	***Air Rotary***
DATES DRILLED:	***1/16/02***	DEVELOPMENT DATE:	***2/22/02***
		LOCATION:	***Approx. 10 ft west of SRMW-4R***

NOTES: SWL = 6.57' below TOC on 1/17/02
TOC elev.: 279.79 ft amsl

ELEVATION: 278.08 ft amsl

NORTHING: 986886.396 EASTING: 685600.953

DEPTH FEET	CUM. BLOWN YIELD	SAMP. #	LITHOLOGY
2			
0			SAND AND SILT: dk brown, organic, with roots and wood fragments
			SAND AND SILT: lt. olive gray to dk yellowish orange, mottled, vf-f sand and silt, some m-c, tr. f SR-R gravel, tr. roots
2			
			SAND & GRAVEL: dk yellowish brown, vf-vc sand with f-m SR-R gravel, some silt, loose, wet
4			
6			
8			
10			
12			
14			
16			
18			CLAY: lt. olive gray, silty, some vf-f sand, dense, wet
20			



WELL CONSTRUCTION DETAILS

6" locking well cap with 2" sealing cap

6' steel protector pipe

Bentonite pellet annular seal, 0' to 5'

2" dia. sch. 40 PVC riser pipe, +2.5' to 7.3'

#00 Grade sand, 5' to 18'

2" dia. 10-slot PVC screen, 7.3' to 17.3'

2" bottom cap

Bentonite chip backfill, 18' to 19'

PROJECT INFORMATION

PROJECT: ***Shenandoah Road Site***
SITE LOCATION: ***Shenandoah, Dutchess Co., NY***
JOB NO.: ***01003.11.0105***
LOGGED BY: ***S. Fisher***
DATES DRILLED: ***12/19/01-1/14/02, 2/5/02-2/6/02***

DRILLING INFORMATION

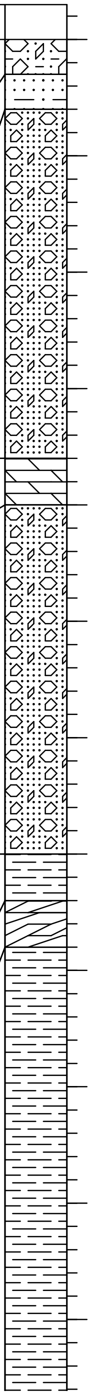
DRILLING CO.: ***Eichelbergers Inc.***
DRILLER: ***Jerry Books, Ed Funk***
RIG TYPE: ***IR T2W, Cable tool***
DRILLING METHOD: ***Air Rotary, Cable tool***
DEVELOPMENT DATE: ***2/15/02***
LOCATION: ***N. side of property at 11 Weitz Road***

NOTES: Well flows slightly with 3 ft of casing stickup
Pre-packed 2-in screen installed 2/6/02
PID = 0 ppm; TOC elev.: 320.63 ft amsl

ELEVATION: 319.11 ft amsl
NORTHING: 979665.736 EASTING: 687198.176

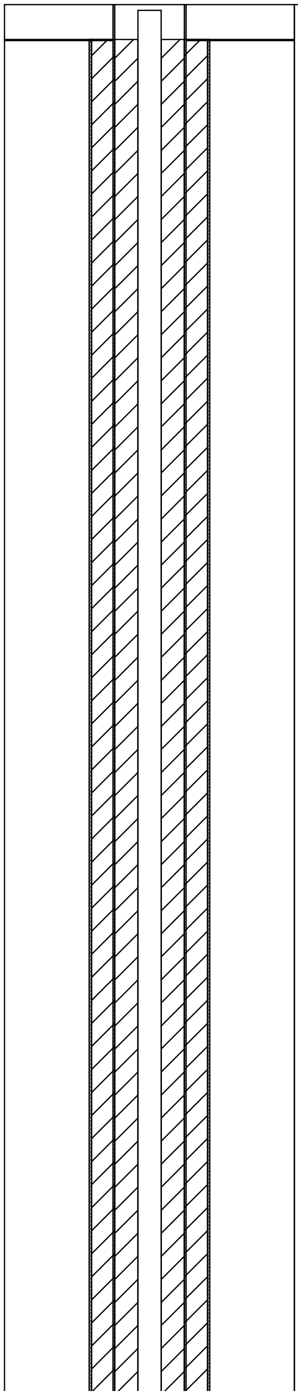
DEPTH FEET	CUM. BLOWN YIELD	SAMP. #	LITHOLOGY
0			SILT, SAND & GRAVEL: dk yellow-brown, pred silt and sand w/ some f SR-R gravel, cohesive, moist SAND AND SILT: olive gray (5Y4/1) silt with some vf-c sand, organic, wet
10			SAND & GRAVEL: light olive gray, silty, vf-c sand and f-m SR-R gravel composed of quartzite and gneiss, loose, wet
20			
30			DOLOSTONE BOULDER: lt gray, weathered dolostone
40			SAND & GRAVEL: light olive gray, stratified, silty, vf-c sand and f-m SR-R gravel composed of quartzite and gneiss, loose, wet
50			
60			
70			CLAY: dk yellowish orange, some silt, with deeply weathered dolostone frags, trace qtz masses, more dense WEATHERED DOLOSTONE: dk yellowish orange, some sl. competent lt gray color, with silt and clay
80			CLAY: dk yellowish orange, some silt, with abundant deeply weathered, limonitic dolostone frags, occ. quartz masses, trace weathered shale frags, some white clay seams, wet
90			
100			
110			

GRAPHIC



DEPTH FEET: 0, 10, 20, 30, 40, 50, 60, 70, 80, 90, 100, 110

WELL CONSTRUCTION



WELL CONSTRUCTION DETAILS

6" locking well cap & 2" sealing cap

10" dia. steel casing with driveshoe, 0' to 140'

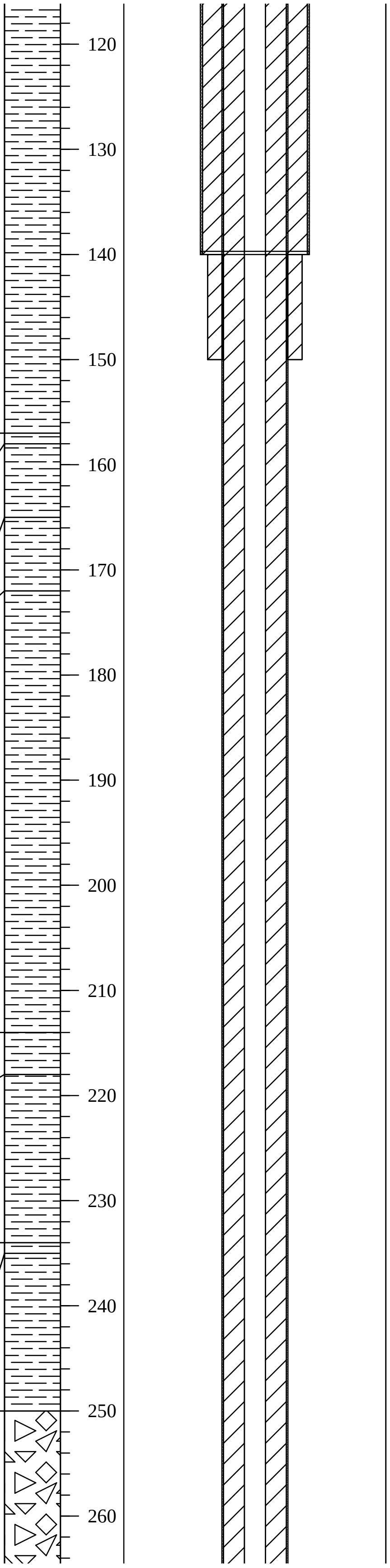
6" dia.steel casing with driveshoe, +3' to 362'

10" x 6" bentonite slurry annular seal, 0' to 150'

6" x 2" bentonite slurry annular seal, 0' to 360'

2" sch 40 PVC riser pipe, +2.5' to 365'

DEPTH FEET	BLOWN YIELD (GPM)	SAMP. #	LITHOLOGY	WELL CONSTRUCTION DETAILS
120				10" dia. steel casing with driveshoe, 0' to 140'
140–150				9" dia. borehole, 140' to 150'
157			CLAY: dk yellowish orange, softer 157'-158'	
158			CLAY: dk yellowish orange, some silt, with abundant deeply weathered, limonitic dolostone frags, occ. quartz masses, trace weathered shale frags, some white clay seams, wet	
165			CLAY: dk yellowish orange, softer zones 165'-168' and 171'-172'	
172			CLAY: dk yellowish orange, some silt, with abundant deeply weathered, limonitic dolostone frags, occ. quartz masses, trace weathered shale frags, some white clay seams, wet	2" sch 40 PVC riser pipe, +2.5' to 365'
200				6" x 2" bentonite slurry annular seal, 0' to 360'
214			CLAY: dk yellowish orange, harder zones 214'-215' and 217'-218'	
218			CLAY: dk yellowish orange, some silt, with abundant deeply weathered, limonitic dolostone frags, occ. quartz masses, trace weathered shale frags, some white clay seams, wet	6" dia.steel casing with driveshoe, +3' to 362'
234			CLAY: dk yellowish orange, harder zones 214'-215' and 217'-218'	
238			CLAY: dk yellowish orange, some silt, with abundant deeply weathered, limonitic dolostone (?) and quartzite frags, occ. quartz masses, trace weathered shale frags, some white clay seams, wet	
250	5 gpm		WEATHERED QUARTZITE: grayish orange with some pale red zones, f-m grained, with c-vc zones, highly fractured, variable competency, limonitic veins and fracture staining throughout, with dk yellowish orange silt and clay, occ. soft muddy zones, water-bearing	



GROUNDWATER SCIENCES CORPORATION

GEOLOGIC LOG: SRMW-5R

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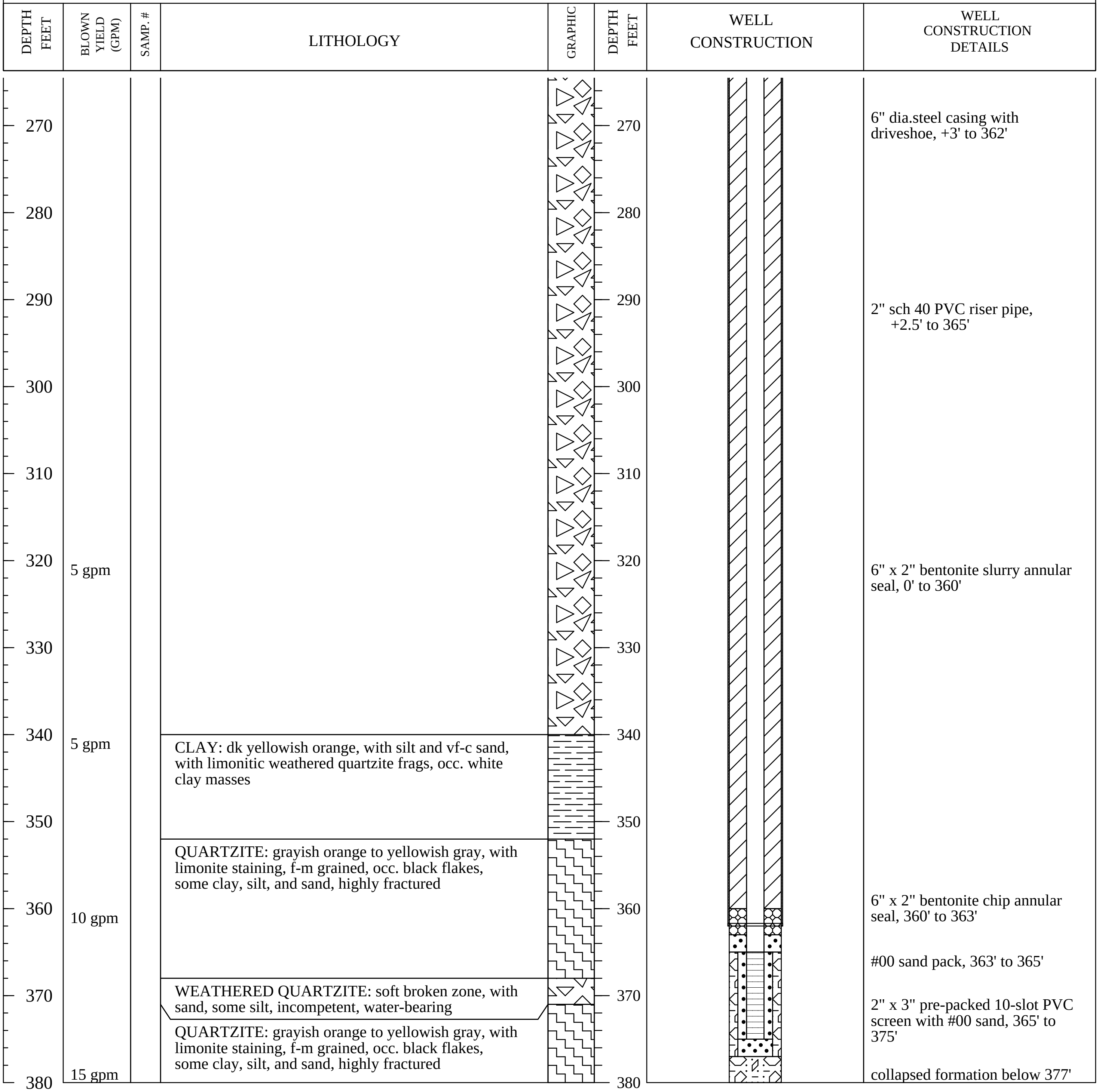

DEPTH FEET	BLOWN YIELD (GPM)	SAMP. #	LITHOLOGY	WELL CONSTRUCTION DETAILS
270				6" dia.steel casing with driveshoe, +3' to 362'
290				2" sch 40 PVC riser pipe, +2.5' to 365'
320	5 gpm			6" x 2" bentonite slurry annular seal, 0' to 360'
340	5 gpm		CLAY: dk yellowish orange, with silt and vf-c sand, with limonitic weathered quartzite frags, occ. white clay masses	
352			QUARTZITE: grayish orange to yellowish gray, with limonite staining, f-m grained, occ. black flakes, some clay, silt, and sand, highly fractured	
360	10 gpm			6" x 2" bentonite chip annular seal, 360' to 363'
365				#00 sand pack, 363' to 365'
368			WEATHERED QUARTZITE: soft broken zone, with sand, some silt, incompetent, water-bearing	
370				2" x 3" pre-packed 10-slot PVC screen with #00 sand, 365' to 375'
371			QUARTZITE: grayish orange to yellowish gray, with limonite staining, f-m grained, occ. black flakes, some clay, silt, and sand, highly fractured	
380	15 gpm			collapsed formation below 377'

GROUNDWATER SCIENCES CORPORATION

GEOLOGIC LOG: SRMW-5S

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PROJECT INFORMATION

PROJECT: ***Shenandoah Road Site***
SITE LOCATION: ***Shenandoah, Dutchess Co., NY***
JOB NO.: ***01003.11.0105***
LOGGED BY: ***S. Fisher***
DATES DRILLED: ***1/10/02-1/11/02***

DRILLING INFORMATION

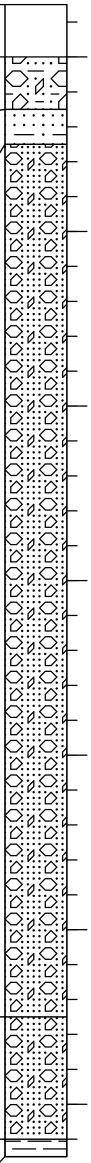
DRILLING CO.: ***Eichelbergers Inc.***
DRILLER: ***Jerry Books***
RIG TYPE: ***IR T2W***
DRILLING METHOD: ***Air Rotary***
DEVELOPMENT DATE: ***3/6/02***
LOCATION: ***Approx. 20 ft W of SRMW-5R, on 11 Weitz Rd. property***

NOTES: Well flowing at 10 gpm w/ 1 ft casing stickup
Casing raised to 2.8 ft; TOC elev.: 322.33 ft amsl
SWL = 1.98 ft below TOC on 1/14/02

ELEVATION: 319.48 ft amsl
NORTHING: 979651.758 EASTING: 687188.575

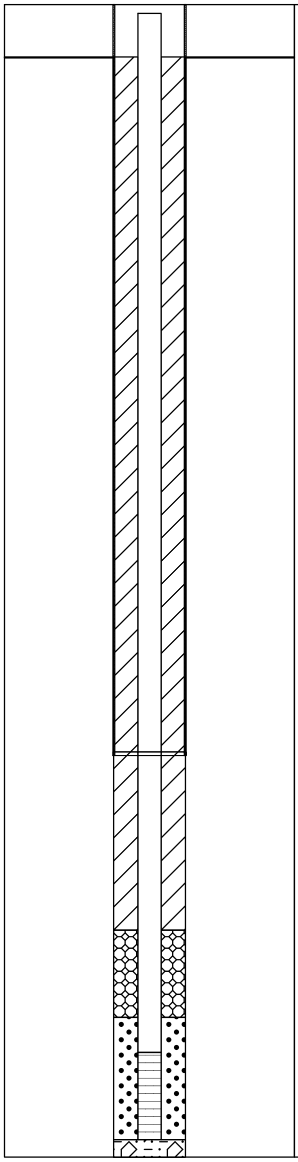
DEPTH FEET	CUM. BLOWN YIELD	SAMP. #	LITHOLOGY
0			SILT, SAND & GRAVEL: dk yellow-brown, pred silt and sand w/ some f SR-R gravel, cohesive, moist
			SAND AND SILT: olive gray (5Y4/1) silt with some vf-c sand, organic, wet
			SAND & GRAVEL: light olive gray, silty, vf-vc sand and f-m SR-R gravel composed of quartzite and gneiss, stratified, loose, wet
10			
20			
30			
40			
50			
			SAND & GRAVEL: dusky yellow, silty, vf-vc sand and f-m SR-R gravel composed of quartzite, gneiss and dolostone, loose, wet
60	10 gpm		
			CLAY: dk yellowish orange, some silt, wet

GRAPHIC



DEPTH FEET

WELL CONSTRUCTION



WELL CONSTRUCTION DETAILS

6" locking well cap with 2" sealing cap

2" dia. sch. 40 PVC riser pipe, +2.5' to 57'

6" dia.steel casing with driveshoe, +3' to 40'

Bentonite slurry annular seal, 0'-50'

Bentonite chip annular seal, 50'-55'

#1 Grade sand, 55'-62'

2" 20-slot PVC screen, 57'-62'

2" bottom cap

Collapsed formation, 62'-63'

GROUNDWATER SCIENCES CORPORATION

GEOLOGIC LOG: SRMW-6R

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PROJECT INFORMATION		DRILLING INFORMATION	
PROJECT:	***IBM--Shenandoah Road Site***	DRILLING CO.:	***Eichelbergers Inc.***
SITE LOCATION:	***Shenandoah, Dutchess Co., NY***	DRILLER:	***Jerry Books***
JOB NO.:	***01003.11.0105***	RIG TYPE:	***IR T2W***
LOGGED BY:	***S. Fisher***	DRILLING METHOD:	***Air Rotary***
		DEVELOPMENT DATE:	***2/28/02***
DATES DRILLED:	***12/4/01- 12/6/01***	LOCATION:	***Empty lot, north side of Griffin Lane, W. of Shenandoah Rd.***

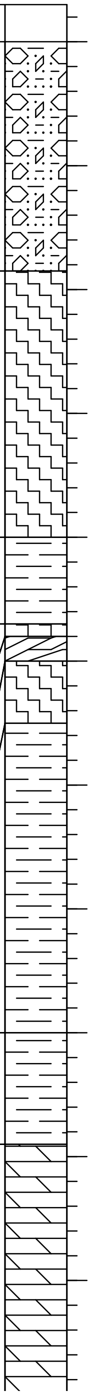
NOTES: WBZs at 36' and 48'-50'
2" PVC well constructed on 2/1/02
Borehole below 50 ft was abandoned

ELEVATION: 335.96 ft amsl

NORTHING: 982995.961 EASTING: 685360.473

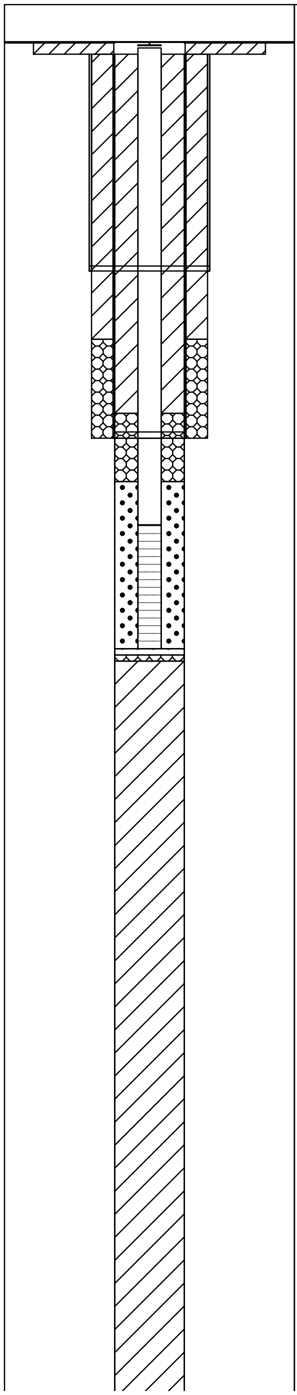
DEPTH FEET	CUM. BLOWN YIELD	SAMP. #	LITHOLOGY
0			SILT, SAND & GRAVEL: dk yellow-brown, pred silt, vf-vc sand w/ some f SR-R gravel, cohesive to loose, moist to dry, roots in top 10'
10			
20	Trace		QUARTZITE: light gray (N7) to lt olive gray, vitreous, with pyritic flecks, some iron-staining, fractured at 36 ft
30			
40			SHALE: grayish black (N2), with pyrite masses, laminated
50	2-3 gpm		QUARTZITE: med gray, vitreous, laminated, tr. fractures FRACTURED QUARTZITE: broken, water-bearing with some orange silt and clay, some sand QUARTZITE: med gray, vitreous, laminated, tr. fractures
60			SHALE: dolomitic, light olive gray (5 Y 6/1), laminated, occ. sheared, some weathered material, tr. quartz
70			
80	2-3 gpm		SHALE: increasingly dolomitic, some pyrite and occasional quartz laminations, tr. iron staining
90			DOLOSTONE: med. lt. gray (N6), finely crystalline, competent, tr. pyrite and quartz, incr. in pyrite below 100 ft
100	2-3 gpm		

GRAPHIC



DEPTH FEET

WELL CONSTRUCTION



WELL CONSTRUCTION DETAILS

Flushmount manhole & 2" locking/sealing cap

Bentonite slurry 10' x 6" annular seal, 1' to 24'

10" dia. steel casing w/ shoe, 1' to 18.5'

6" dia.steel casing with driveshoe, 1' to 32'

Bentonite slurry 2" x 6" annular seal, 1' to 30'

Bentonite chip 6" x 10" annular seal, 24' to 32'

Bentonite chip 2" x 6"annular seal, 30' to 35.5'

2" dia. 20-slot PVC screen, 39' to 49'

#1 grade sand, 35.5' to 49.5'

Bentonite chip seal, 49.5' to 50'

Plugged 6" dia. borehole, 50' to 502'

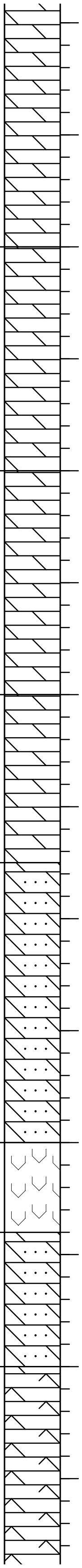
GROUNDWATER SCIENCES CORPORATION

GEOLOGIC LOG: **SRMW-6R**

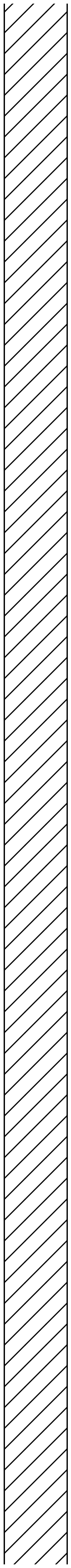
DEPTH FEET	BLOWN YIELD (GPM)	SAMP. #	LITHOLOGY	GRAPHIC	DEPTH FEET	WELL CONSTRUCTION	WELL CONSTRUCTION DETAILS
110			DOLOSTONE: v. lt gray, with dolomitic limestone zones, tr. pyrite		110		
120	2-3 gpm		LIMESTONE: v. lt. gray to white, high purity, specular, some dolomitic limestone, tr. pyrite and lt. olive gray shale laminations below 135 ft		120		
130					130		Plugged 6" dia. borehole, 50' to 502'
140	2-3 gpm		INTERBEDDED LIMESTONE & DOLOSTONE: med. lt. gray (N6), some dolomitic limestone, homogeneous texture, some calcite veining, tr. pyrite		140		
150					150		
160	2-3 gpm		DOLOSTONE: med dk gray, fine-med. crystalline, tr. pyrite and calcite veining		160		
170					170		
180	2-3 gpm				180		
190					190		
200	2-3 gpm		DOLOMITIC LIMESTONE: med lt gray. homogeneous		200		
210			DOLOSTONE: med dk gray, fine crystalline, graphitic, with white calcite veining and pyrite-rich zones		210		
220	2-3 gpm				220		
230					230		
240	2-3 gpm		DOLOSTONE: med gray (N5)		240		

DEPTH FEET	BLOWN YIELD (GPM)	SAMP. #	LITHOLOGY	WELL CONSTRUCTION DETAILS
250				
260	3 gpm			Plugged 6" dia. borehole, 50' to 502'
270			DOLOSTONE: dk gray (N3) med. crystalline, with pyrite-rich laminations, graphitic, tr. calcite	
280	3 gpm			
290			DOLOSTONE: med dk gray, trace pyrite	
300	3 gpm			
310			DOLOSTONE: med gray to med lt gray, fine to med crystalline, tr. pyrite	
320	3-4 gpm			
			SANDY DOLOSTONE: med gray to brownish gray, hard, quartzose, tr. pyrite	
330				
340	3-4 gpm			
350			QUARTZ: white, high purity, tr med gray dolostone	
			SANDY DOLOSTONE: med gray to brownish gray, quartzose, with quartz veins, tr. pyrite	
360	3-4 gpm			
370			DOLOMITIC SHALE: dk gray to grayish black (N2), laminated, graphitic, occ. quartz veins, tr. pyrite	
380	3-4 gpm			

GRAPHIC



WELL CONSTRUCTION



DEPTH FEET	BLOWN YIELD (GPM)	SAMP. #	LITHOLOGY	WELL CONSTRUCTION DETAILS
390			QUARTZITE: med gray to med dk gray, v. hard, slightly dolomitic/calcic in places, some disseminated pyrite flecks, some lt olive gray zones, tr. grayish black shale laminations near top	
400	3-4 gpm			Plugged 6" dia. borehole, 50' to 502'
410				
420	3-4 gpm			
430				
440	3-4 gpm		QUARTZITE: as above with trace of slickensided surfaces, tr. green laminations	
			QUARTZITE: med gray to med dk gray, v. hard, slightly dolomitic/calcic in places, some disseminated pyrite flecks, some lt olive gray zones, tr. grayish black shale laminations near top	
450				
460	3-4 gpm			
470			QUARTZITE: some brownish gray, sl. iron-stained, fractured, no water	
			QUARTZITE: med gray, trace iron-staining, slightly finer grained below 490 ft	
480	3-4 gpm			
490				
500	3-4 gpm			

GEOLOGIC LOG: SRMW-7R

Page 1 of 3

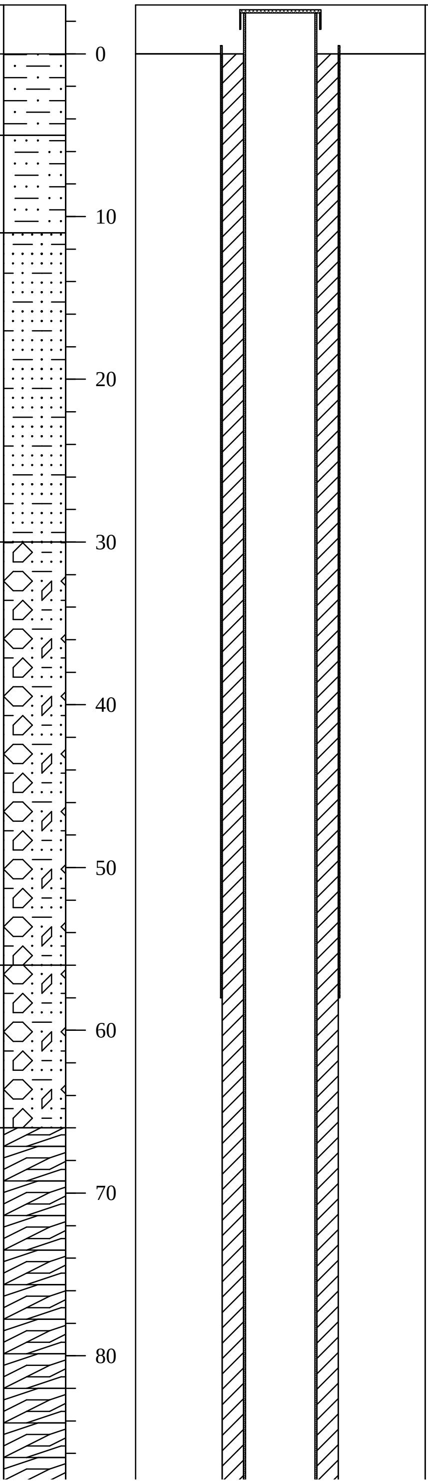
PROJECT INFORMATION		DRILLING INFORMATION	
PROJECT:	*Shenandoah Alternative Water Supply*	DRILLING CO.:	*Eichelbergers Inc.*
SITE LOCATION:	*Town of East Fishkill, Dutchess Co., NY*	DRILLER:	*J. Books*
JOB NO.:	*01003.11.0105*	RIG TYPE:	*IR T4W*
LOGGED BY:	*E. Stoner/ S. Fisher*	DRILLING METHOD:	*Air Rotary*
DATES DRILLED:	*3/07/03 - 3/12/03*	DEVELOPMENT DATE:	*3/12/03*
		LOCATION:	*East of Patti Place, on J. Greico property*

NOTES: SWL= 0.5' below casing rim, 3/13/03 (artesian)
Well completed as a 6"dia. open borehole
150+ gpm blown yield

ELEVATION: 331.14 ft amsl

NORTHING: 980071.61 EASTING: 688067.48

DEPTH FEET	CUM. BLOWN YIELD	SAMP. #	LITHOLOGY	GRAPHIC	DEPTH FEET	WELL CONSTRUCTION	WELL CONSTRUCTION DETAILS



Depth scale (feet): 0, 10, 20, 30, 40, 50, 60, 70, 80

LITHOLOGY

SILT: dark yellowish brown (10 YR 4/2) organic-rich silt, some clay, moist

SANDY SILT: light brown (5 YR 5/6) silt, some clay and sand, moist

SAND & SILT: olive gray (5 Y 4/1) silt & sand, some clay, trace f-m gravel, firm silt at 19'

SILT, SAND & GRAVEL: lt. olive gray (5 Y 6/1) silt and vf-vc sand matrix, with abundant A-SR dolostone gravel, cobbly, poorly sorted

SILT, SAND & GRAVEL: dusky yellowish brown (5 Y 6/4) matrix with predominantly dk gray to med gray A-SR dolostone frags, w/ pebbles and cobbles of various lithologies, occ. R pebble, occ. boulder

WEATHERED QUARTZITE: yellowish gray (5 Y 7/2) to pale yellowish orange (10 YR 8/6) f-m grained quartzite, with abundant iron and manganese stained fractures, occ. highly fractured zones, water-bearing

WELL CONSTRUCTION DETAILS

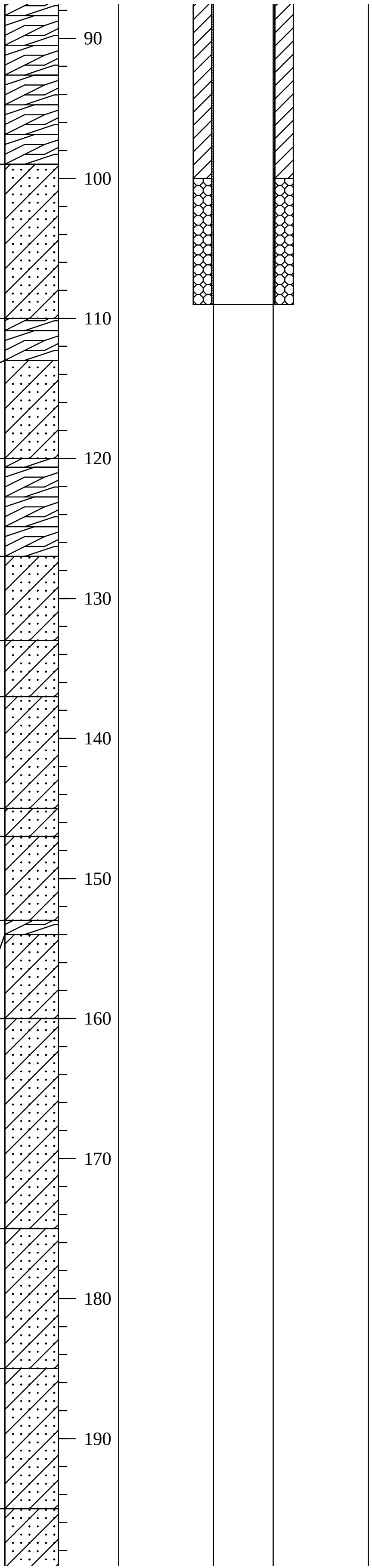
6" locking well cap

Bentonite slurry annular seal, 0' to 100'

10" dia. steel casing with driveshoe, 0' to 58'

6" dia.steel casing with driveshoe, +2.5' to 109'

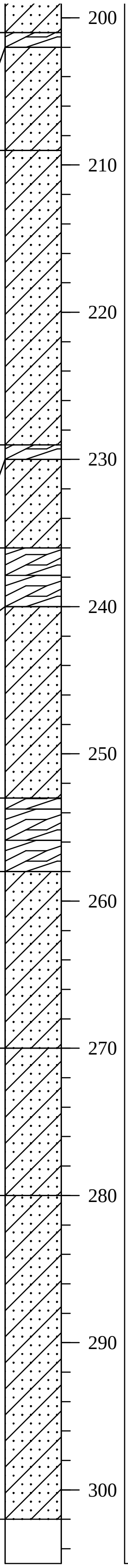
BLOWN YIELD (GPM)	SAMP. #	LITHOLOGY	WELL CONSTRUCTION DETAILS
		QUARTZITE: more competent, fine grained, more yellowish gray w/ some grayish orange, occ. iron-stained fractures	Bentonite pellet annular seal, 100' to 109'
1 gpm		WEATHERED QUARTZITE: soft, broken, increase in iron-staining	
		QUARTZITE: competent, grayish yellow to grayish orange	
		WEATHERED QUARTZITE: soft, broken, abundant iron-stained fractures, limonitic	
10 gpm		QUARTZITE: competent, some iron staining	
		QUARTZITE: dark yellowish orange (10 YR 6/6) vitreous, competent, tr limonite	
		QUARTZITE: yellowish gray, competent, some iron-staining	
		QUARTZITE: increased iron-stained fractures	
		QUARTZITE: yellowish gray (5 Y 7/2) to lt olive gray (5 Y 6/1), homogeneous, little iron-staining	6" dia. open borehole
20 gpm		WEATHERED QUARTZITE: soft, broken zone, water-bearing	
		QUARTZITE: yellowish gray with increased iron-staining	
		QUARTZITE: cleaner, yellowish gray, some iron-staining	
30 gpm		QUARTZITE: yellowish gray, some lt gray (N7) w/ iron-stained fractures	
		QUARTZITE: lt gray to yellowish gray, some yellowish orange mottling, w/ iron-stained fractures, tr yellowish gray phyllite laminations	
		QUARTZITE: hard, yellowish gray to grayish orange	

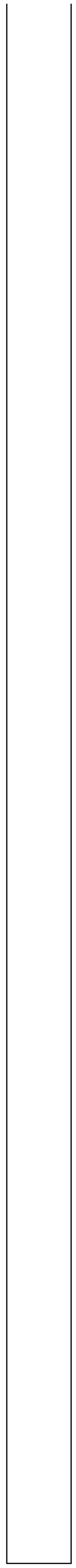


GROUNDWATER SCIENCES CORPORATION

GEOLOGIC LOG: SRMW-7R

DEPTH FEET	BLOWN YIELD (GPM)	SAMP. #	LITHOLOGY	WELL CONSTRUCTION DETAILS
200				
	50 gpm		WEATHERED QUARTZITE: yellowish gray, fractured, limonitic, water-bearing	
			QUARTZITE: yellowish gray, competent	
210			QUARTZITE: yellowish gray, with dark gray (N3) to med dk gray (N5) phyllite stringers, abundant iron-staining, tr quartz veining, some med lt gray (N6) quartzite	
220				6" dia. open borehole
	50 gpm			
230			WEATHERED QUARTZITE: soft, broken, water-bearing	
			QUARTZITE: yellowish gray to lt gray, iron-stained, tr white quartz	
			WEATHERED QUARTZITE: softer, increased iron-staining, some dk yellowish orange silt, water-bearing	
240			QUARTZITE: pred yellowish gray, with dark gray phyllite stringers, phyllite-rich around 250'	
250				
	75 gpm		WEATHERED QUARTZITE: soft, broken, phyllitic, w/ abundant iron-staining, water-bearing	
260			QUARTZITE: yellowish gray, competent, cleaner, tr iron-staining	
270			QUARTZITE: yellowish gray, competent with increased iron-staining, some iron-stained phyllite	
280	100 gpm		QUARTZITE: yellowish gray, competent, with occ. soft zones, tr phyllite, frequent iron-stained fractures	
290				
300	>150 gpm			





GROUNDWATER SCIENCES CORPORATION

GEOLOGIC LOG: SRMW-7S

Page 1 of 1

PROJECT INFORMATION

PROJECT:	***Shenandoah Alternative Water Supply***
SITE LOCATION:	***Town of East Fishkill, Dutchess Co., NY***
JOB NO.:	***01003.11.0105***
LOGGED BY:	***S. Fisher***
DATES DRILLED:	***3/12/03 - 3/13/03***

DRILLING INFORMATION

DRILLING CO.:	***Eichelbergers Inc.***
DRILLER:	***J. Books***
RIG TYPE:	***IR T4W***
DRILLING METHOD:	***Air Rotary***
DEVELOPMENT DATE:	***3/19/03 - 3/20/03***
LOCATION:	***10 ft east of SRMW-7R on J. Greico property***

NOTES: SWL= 8.5' below casing rim, 3/14/03
Well completed as a 2"dia. piezometer

ELEVATION: 332.30 ft amsl

NORTHING: 980075.19 EASTING: 688078.27

DEPTH FEET	CUM. BLOWN YIELD	SAMP. #	LITHOLOGY	GRAPHIC	DEPTH FEET	WELL CONSTRUCTION	WELL CONSTRUCTION DETAILS

DEPTH FEET: 0, 10, 20, 30, 40, 50, 60, 70

LITHOLOGY

SILT: dark yellowish brown (10 YR 4/2) organic-rich silt, some clay, moist

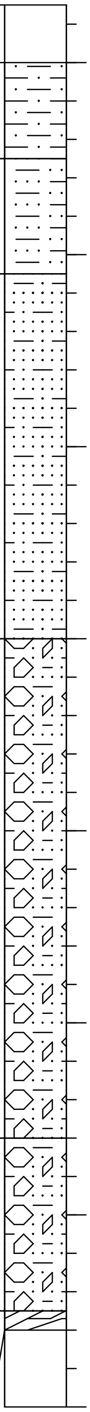
SANDY SILT: light brown (5 YR 5/6) silt, some clay and sand, moist

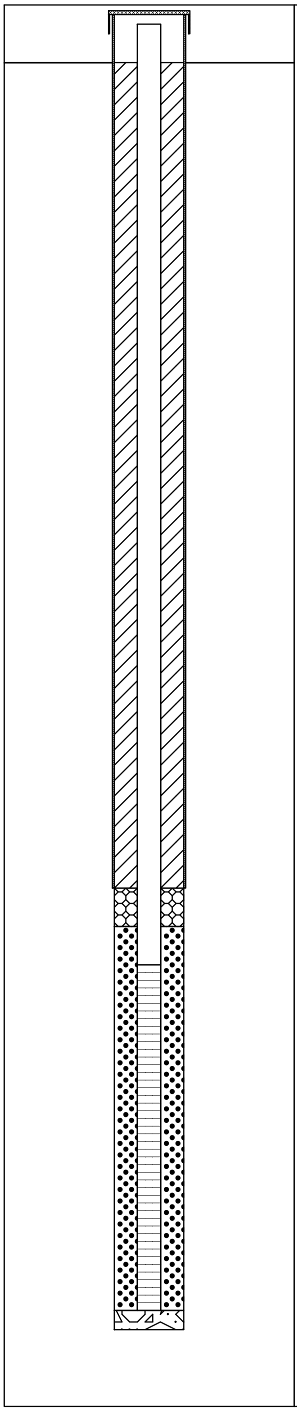
SAND & SILT: olive gray (5 Y 4/1) silt & sand, some clay, trace f-m gravel, firm silt at 19'

SILT, SAND & GRAVEL: lt. olive gray (5 Y 6/1) silt and vf-vc sand matrix, with abundant A-SR dolostone gravel, cobbly, poorly sorted

SILT, SAND & GRAVEL: dusky yellowish brown (5 Y 6/4) matrix with predominantly dk gray to med gray A-SR dolostone frags, w/ pebbles and cobbles of various lithologies, occ. R pebble, occ. boulder

WEATHERED QUARTZITE: yellowish gray (5 Y 7/2) to pale yellowish orange (10 YR 8/6) f-m grained quartzite, with abundant iron and manganese stained fractures





WELL CONSTRUCTION DETAILS

6" locking well cap

2" sch. 40 PVC riser pipe, 2' to 47'

Bentonite slurry annular seal, 0' to 43'

6" dia.steel casing with driveshoe, +2.5' to 43'

Bentonite chip annular seal, 43' to 45'

#0 sand, 45' to 65'

2" dia. 10-slot PVC screen, 47' to 65'

collapsed formation, 65' to 66'

GEOLOGIC LOG: SRMW-8R

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PROJECT INFORMATION

PROJECT: *Shenandoah Alternative Water Supply*
SITE LOCATION: *Town of East Fishkill, Dutchess Co., NY*
JOB NO.: *01003.11.0105*
LOGGED BY: *E. Stoner*
DATES DRILLED: *1/29/03 - 1/30/03*

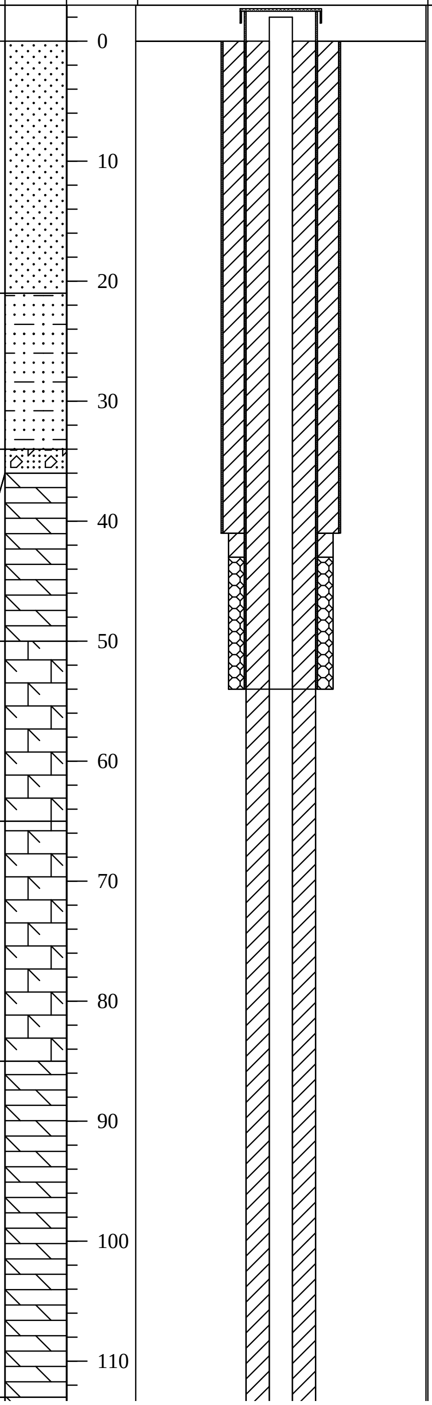
DRILLING INFORMATION

DRILLING CO.: *Eichelbergers Inc.*
DRILLER: *C. Brenneman*
RIG TYPE: *Schramm*
DRILLING METHOD: *Air Rotary*
DEVELOPMENT DATE: *3/24/03*
LOCATION: *N. of Jackson Road, E. of SRMW-2R*

NOTES: SWL= 49.50' below casing rim, 1/31/03
Top of casing elevation: 370.29 ft amsl
2-inch piezometer installed June 29, 2006

SURFACE ELEVATION: 368.12 ft amsl
NORTHING: 984669.255 EASTING: 688614.310

DEPTH FEET	CUM. BLOWN YIELD	VOC (ppm)	LITHOLOGY
0			SAND: dark yellowish brown, f-m, some vf, trace vc and f gravel, tr. clay, thin gravel layers at 11', 14', & 19', moist
10			
20			SAND & SILT: vf sand & silt,some f-m sand, tr. clay, more silt and clay below 30', moist
30			SAND & GRAVEL: sand with SA-SR gravel, predominantly dolostone with some quartzite and gneiss
40			DOLOSTONE: med bluish gray (5 B 5/1), with occasional thin laminations of white (N9) dolostone below 47'
50			DOLOMITIC LIMESTONE: dark gray (N3) to grayish black (N2), with occasional laminations of white dolostone, translucent quartz vein at 50'
60	0 gpm		DOLOMITIC LIMESTONE: dark gray to grayish black
70			
80	0 gpm		DOLOSTONE: grayish black, occasional laminations of white dolostone 85' to 95', pyritic and shaly 89' to 90' with quartz veins
90			
100	0 gpm		
110			



WELL CONSTRUCTION DETAILS

6" locking well cap

10" dia. steel casing with driveshoe, 0' to 41'

Bentonite slurry 6x10 annular seal, 0' to 43'

6" dia.steel casing with driveshoe, +2.5' to 54'

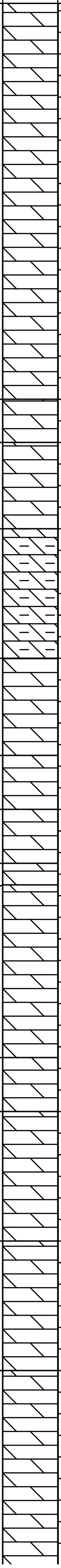
9" dia. borehole, 41' to 54'

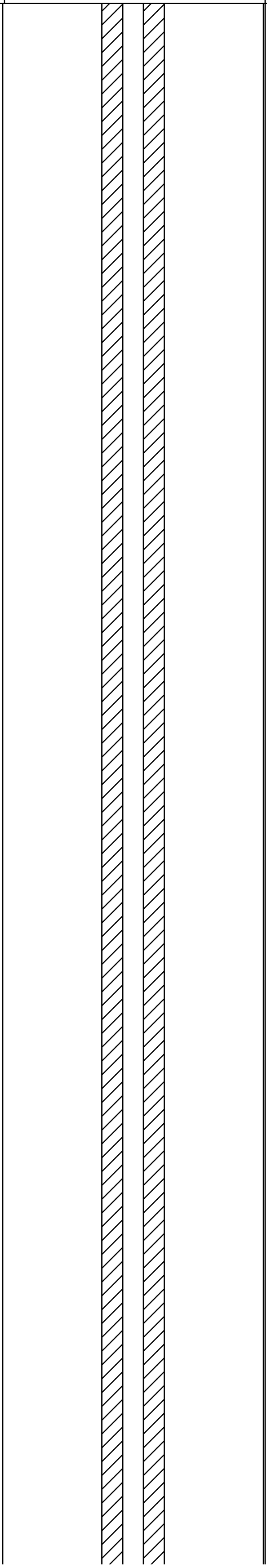
Bentonite chip 6x9 annular seal, 43' to 54'

6" dia. air rotary borehole, 54'-401'

Bentonite slurry 2x6 annular seal, 0'-315'

2-inch dia. sch. 40 PVC riser, +1.5'-325'

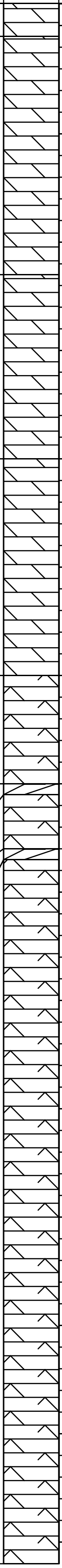




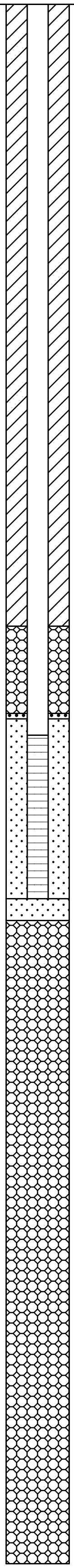
DEPTH FEET	BLOWN YIELD (GPM)	VOC (ppm)	LITHOLOGY	WELL CONSTRUCTION DETAILS
			DOLOSTONE: med dark gray (N4) to med bluish gray, calcareaous, with occasional pyrite, shaly and pyritic 137' to 138'	
120	0 gpm			
130				
140	<0.5 gpm			6" dia. air rotary borehole, 54'-401'
150			DOLOSTONE: medium gray, soft at 154' DOLOSTONE: interbedded med light gray (N6) and dark greenish gray (5 G 4/1), hard	
160	<0.5 gpm		SHALY DOLOSTONE: med gray (N5) dolostone with layers of greenish gray (5 GY 6/1) shale	
170			DOLOSTONE: med gray to med bluish gray, shaly 175' to 176', pyrite vein at 180'	
180	<0.5 gpm		DOLOSTONE: med gray to med light gray, calcareous DOLOSTONE: med dark gray, trace of white to translucent dolostone	
190			DOLOSTONE: med light gray DOLOSTONE: interbedded med light gray to light gray (N7) with med gray shaly layers	Bentonite slurry 2x6 annular seal, 0'-315'
200	<0.5 gpm			
210			DOLOSTONE: light gray to very light gray (N8), calcareous DOLOSTONE: med light gray to med gray, calcareous	
220	<0.5 gpm		DOLOSTONE: med dark gray, shaly	
230				
240	<0.5 gpm		DOLOSTONE: med gray to med light gray, with greenish gray and very light gray layers at 260', tr pyrite, calcareous	2-inch dia. sch. 40 PVC riser, +1.5'-325'
250				

DEPTH FEET	BLOWN YIELD (GPM)	VOC (ppm)	LITHOLOGY
260	<0.5 gpm		DOLOSTONE: med light gray to medium gray, tr coarsely crystalline white calcareous dolostone
270			
280	<0.5 gpm		DOLOSTONE: med dark gray
290			
300	<0.5 gpm		DOLOSTONE: dark gray to med dark gray, some coarse crystalline light gray bands, some pyrite encrusted layers
310			
320	<0.5 gpm		DOLOMITIC SHALE: occasional coarse crystalline dolostone, occasional pyritic zones
330			FRACTURED DOLOSTONE: broken, water-bearing DOLOMITIC SHALE: occasional coarse crystalline dolostone, occasional pyritic zones FRACTURED DOLOSTONE: broken, water-bearing
340	40 gpm		DOLOMITIC SHALE: occasional coarse crystalline dolostone, occasional pyritic zones, thin fractures at 352' and 356'
350			
360	40 gpm		
370			
380	40 gpm		
390			
400	40 gpm		

GRAPHIC



WELL CONSTRUCTION



WELL CONSTRUCTION DETAILS

6" dia. air rotary borehole, 54'-401'

Bentonite slurry 2x6 annular seal, 0'-315'

2-inch dia. sch. 40 PVC riser, +1.5'-325'

Bentonite chip 2x6 annular seal, 315' to 323'

#1 grade choke sand, 323'-323.5'

#2 grade sand pack, 323.5'-342'

20-slot PVC screen, 325'-340'

Bentonite chip backfill, 342'-401'

Total depth: 401 ft

GROUNDWATER SCIENCES CORPORATION

GEOLOGIC LOG: SRMW-9R

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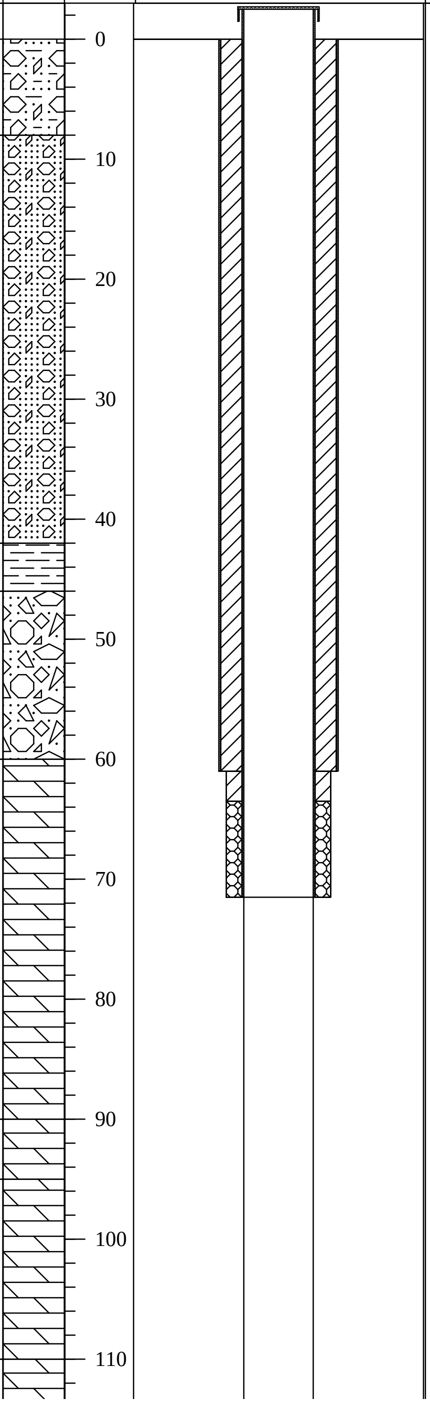
PROJECT INFORMATION		DRILLING INFORMATION	
PROJECT:	*Shenandoah Alternative Water Supply*	DRILLING CO.:	*Eichelbergers Inc.*
SITE LOCATION:	*Town of East Fishkill, Dutchess Co., NY*	DRILLER:	*C. Brenneman*
JOB NO.:	*01003.11.0105*	RIG TYPE:	*Schramm*
LOGGED BY:	*E. Stoner*	DRILLING METHOD:	*Air Rotary*
		DEVELOPMENT DATE:	*3/20/03*
DATES DRILLED:	*1/9/03 - 1/14/03*	LOCATION:	*S. of Jackson Road, S. of SRMW-2R*

NOTES: SWL= 58.27' below casing rim, 1/15/03
Top of casing elevation: 378.38 ft amsl
170 gpm blown yield

SURFACE ELEVATION: 376.26 ft amsl

NORTHING: 983734.983 EASTING: 688524.703

DEPTH FEET	CUM. BLOWN YIELD	VOC (ppm)	LITHOLOGY
0			SILT, SAND & GRAVEL: dark yellowish brown (10 YR 4/2)
10			SAND & GRAVEL: dark yellowish brown, with sand, some silt, gravel composed of shale, dolostone, limestone, quartzite, and gneiss
20			
30			
40			
			CLAY: dark yellowish brown, wet
			GRAVEL: broken, SA dark gray (N3) dolostone, tr. sand, silt and clay
50			
60			DOLOSTONE: competent, dark gray, trace of calcite veining
70			
80	<0.5 gpm		
90			DOLOSTONE: dark gray, some weathered material
			DOLOSTONE: dark gray, trace calcite veining
100	<0.5 gpm		
110			DOLOSTONE: dark gray, trace pyrite



WELL CONSTRUCTION DETAILS

6" locking well cap

10" dia. steel casing with driveshoe, 0' to 61'

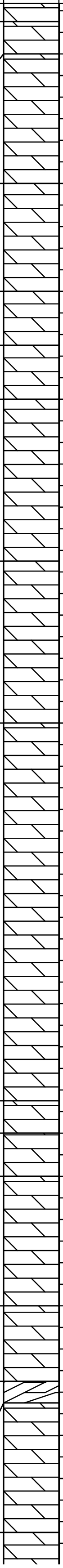
Bentonite slurry annular seal, 0' to 63.5'

6" dia.steel casing with driveshoe, +2.0' to 71.5'

9" dia. borehole, 61' to 71.5'

Bentonite chip annular seal, 63.5' to 71.5'

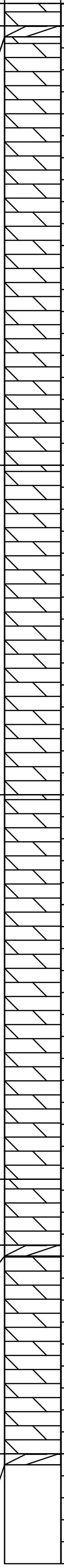
6" dia. open borehole, 71.5' to 391'



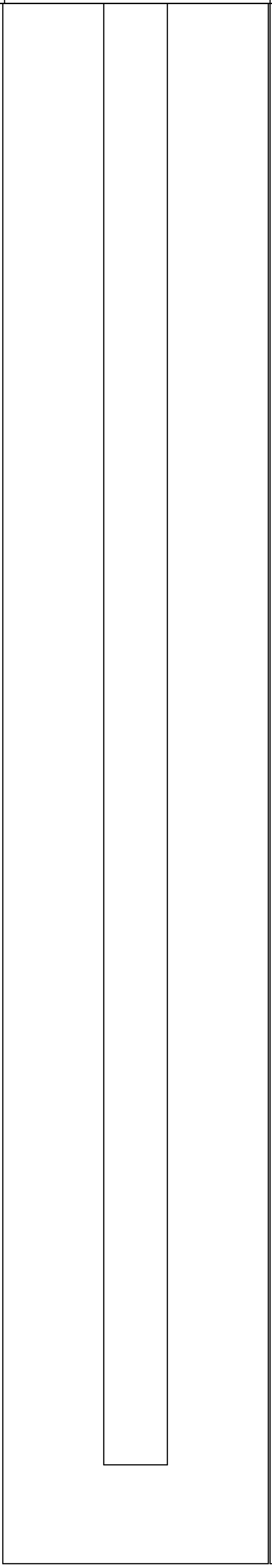
DEPTH FEET	BLOWN YIELD (GPM)	VOC (ppm)	LITHOLOGY	WELL CONSTRUCTION	WELL CONSTRUCTION DETAILS
			DOLOSTONE: med light gray (N6) to light gray (N7), trace weathered material		
120	<0.5 gpm		DOLOSTONE: dark gray, trace pyrite		
130			DOLOSTONE: dark gray, trace pyrite and calcite veins, soft, fractured zone at 131'		
140	<0.5 gpm		DOLOSTONE: grayish black (N2), trace calcite veins DOLOSTONE: medium gray (N5), thin fracture at 149'		
150			DOLOSTONE: dark gray, thin fracture at 164'		6" dia. open borehole, 71.5' to 391'
160	1 gpm		DOLOSTONE: medium dark gray (N4)		
170					
180			DOLOSTONE: medium gray, weathered at 190' and 205'		
190					
200	1 gpm				
210			DOLOSTONE: medium light gray with calcite veins		
220			DOLOSTONE: light gray DOLOSTONE: medium gray		
230			DOLOSTONE: medium light gray to light gray, finely crystalline, tr. pyrite		
240	1 gpm		FRACTURED DOLOSTONE: medium gray to light gray, soft DOLOSTONE: medium light gray to light gray, finely crystalline, tr. pyrite		
250			DOLOSTONE: med light gray to light gray, tr pyrite		

DEPTH FEET	BLOWN YIELD (GPM)	VOC (ppm)	LITHOLOGY	WELL CONSTRUCTION DETAILS
260	10 gpm		FRACTURED DOLOSTONE: water-bearing, no visible weathering	
			DOLOSTONE: medium light gray to light gray, tr pyrite	
270				
280	10 gpm			
290				
300			DOLOSTONE: medium gray to med light gray, finely crystalline	6" dia. open borehole, 71.5' to 391'
310				
320				
330			DOLOSTONE: medium dark gray, finely crystalline, minor calcite veins, soft zone at 364'	
340				
350				
360				
			DOLOSTONE: medium dark gray, tr. pyrite, occasional calcite veining	
370				
			FRACTURED DOLOSTONE	
			DOLOSTONE: medium dark gray, tr. pyrite, occasional calcite veining	
380				
390	170 gpm		FRACTURED DOLOSTONE: water-bearing, no weathered material	Total depth: 391 ft
400				

GRAPHIC



WELL CONSTRUCTION



GROUNDWATER SCIENCES CORPORATION

GEOLOGIC LOG: SRMW-9S

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PROJECT INFORMATION

PROJECT: *Shenandoah Alternative Water Supply*
SITE LOCATION: *Town of East Fishkill, Dutchess Co., NY*
JOB NO.: *01003.11.0105*
LOGGED BY: *E. Stoner*
DATES DRILLED: *1/14/03 - 1/15/03*

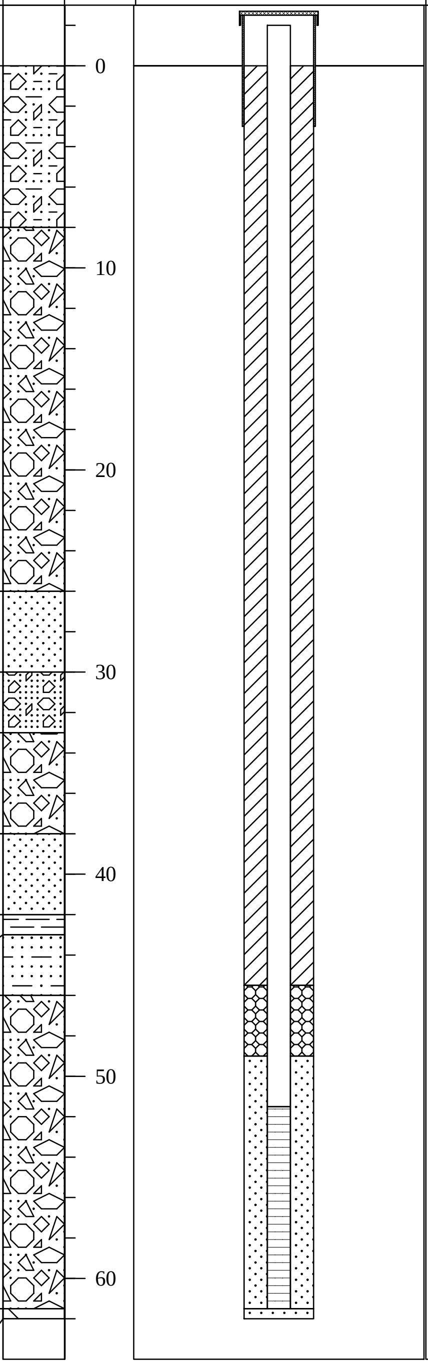
DRILLING INFORMATION

DRILLING CO.: *Eichelbergers Inc.*
DRILLER: *C. Brenneman*
RIG TYPE: *Schramm*
DRILLING METHOD: *Air Rotary*
DEVELOPMENT DATE: *3/20/03*
LOCATION: *S. of Jackson Road, 10' N of SRMW-9R*

NOTES: Well completed as a 2" dia. piezometer
SWL = 53.92' below casing rim, 1/16/03
Top of casing elevation: 377.44 ftamsl

SURFACE ELEVATION: 375.76 ft amsl
NORTHING: 983740.407 EASTING: 688518.973

DEPTH FEET	CUM. BLOWN YIELD	VOC (ppm)	LITHOLOGY
0			SILT, SAND & GRAVEL: dark yellowish brown
10 20			GRAVEL: dark yellowish brown, some sand and silt, gravel composed of shale, limestone, dolostone, quartzite, and gneiss
			SAND: dark yellowish brown, fine to medium, moist
30			SAND & GRAVEL: dark yellowish brown, finr to medium, with gravel
			GRAVEL: composed of various lithologies, trace sand, dry
40			SAND: mod. yellowish brown, very fine, some clay, moist
			CLAY: dark yellowish orange, trace silt, wet
			SAND & SILT: v. fine sand with silt and clay, moist
50 60			GRAVEL: predominantly dark gray SA dolostone, tr sand, silt and clay, few quartzite pebbles
			DOLOSTONE: dark gray



WELL CONSTRUCTION DETAILS

6" steel locking well cap

6" dia. steel casing with driveshoe, +2.5' to 3'

Bentonite slurry annular seal, 0' to 45.5'

2" dia.sch 40 PVC riser pipe, +2.0 to 51.5'

Bentonite chip annular seal, 45.5' to 49'

2" dia. 10-slot PVC screen, 51.5' to 61.5'

#0 sand, 49' to 62'

GEOLOGIC LOG: SRMW-10R

PROJECT INFORMATION

PROJECT: ***Shenandoah Alternative Water Supply***
SITE LOCATION: ***Town of East Fishkill, Dutchess Co., NY***
JOB NO.: ***01003.11.0105***
LOGGED BY: ***E. Stoner***
DATES DRILLED: ***1/16/03 - 1/21/03***

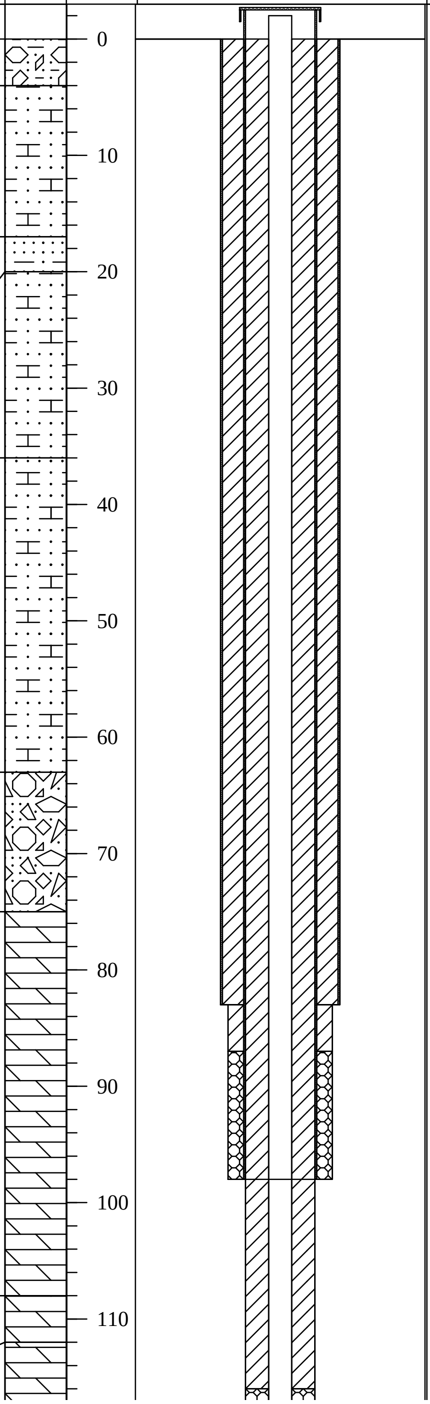
DRILLING INFORMATION

DRILLING CO.: ***Eichelbergers Inc.***
DRILLER: ***C. Brenneman***
RIG TYPE: ***Schramm***
DRILLING METHOD: ***Air Rotary***
DEVELOPMENT DATE: ***3/23/03***
LOCATION: ***S. of Jackson Road, along private dirt road***

NOTES: SWL = 39.96' below casing rim, 1/22/03
Top of casing elevation: 358.63 ft amsl
2-inch piezometer installed June 29, 2006

SURFACE ELEVATION: 356.60 ft amsl
NORTHING: 982733.822 EASTING: 688169.064

DEPTH FEET	CUM. BLOWN YIELD	VOC (ppm)	LITHOLOGY
0			
			SILT, SAND & GRAVEL: dark yellowish brown
			CLAY & SILT: moderate olive brown (5 Y 4/4)
10			
			SAND & SILT: moderate olive brown, vf sand w/ silt and clay
20			
			CLAY & SILT: moderate olive brown (5 Y 4/4)
30			
			CLAY & SILT: med gray (N5) clay, some silt, tr fine gravel and vc sand, increasing gravel below 59'
40			
50			
60			
			GRAVEL: subangular dolostone fragments
70			
			DOLOSTONE: medium dark gray (N4) to dark gray (N3) competent, occ. weathered zones decreasing below 94'
80			
90			
100	0 gpm		
110			DOLOSTONE: dark gray to grayish black (N2), trace of weathered material
			DOLOSTONE: dark gray to grayish black, competent



WELL CONSTRUCTION DETAILS

6" locking well cap

10" dia. steel casing with driveshoe, 0' to 83'

6" dia.steel casing with driveshoe, +2.5' to 98'

Bentonite slurry 6x10 annular seal, 0' to 87'

9" dia. borehole, 83' to 98'

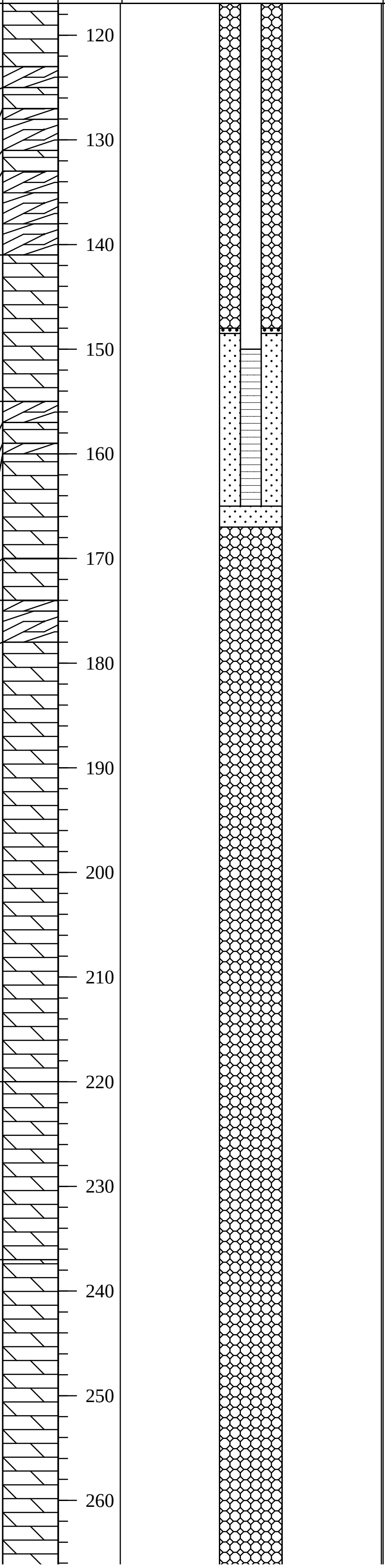
Bentonite chip 6x9 annular seal, 87' to 98'

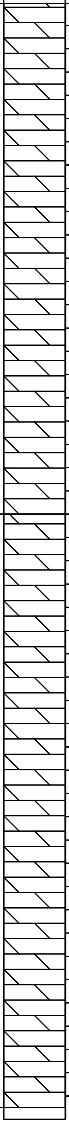
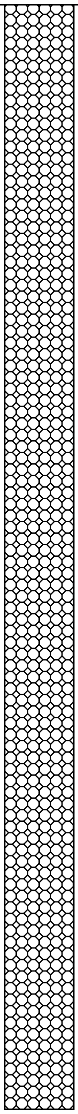
6" dia. air rotary borehole, 98'-361'

Bentonite slurry 2x6 annular seal, 0-116'

2" dia. sch. 40 PVC riser, +1.5'-150'

DEPTH FEET	BLOWN YIELD (GPM)	VOC (ppm)	LITHOLOGY	WELL CONSTRUCTION DETAILS
120				6" dia. air rotary borehole, 98'-361'
	0 gpm			
			WEATHERED DOLOSTONE: soft, broken	
			DOLOSTONE: med gray to med light gray (N6), some weathered material	
130				Bentonite chip 2x6 annular seal, 116'-148'
			WEATHERED DOLOSTONE: soft, broken	
			DOLOSTONE: competent	
			WEATHERED DOLOSTONE: soft, deeply weathered 139'-141'	
140				2" dia. sch. 40 PVC riser, +1.5'-150'
	0 gpm		DOLOSTONE: med dark gray, trace of weathered material, trace of pyrite	
				#1 grade choke sand, 148'-148.5'
150				
			WEATHERED DOLOSTONE: dark yellowish orange (10 YR 6/6), deeply weathered, with clay	#2 grade sand pack, 148.5'-167'
160			DOLOSTONE: med gray tr. calcite, sl. weathered	2" dia. 20-slot screen, 150'-165'
	15 gpm		FRACTURED DOLOSTONE: broken, some orange silt, water-bearing	
			DOLOSTONE: med gray, tr. calcite, more competent below 161'	
170			DOLOSTONE: med gray, trace weathered material	
			WEATHERED DOLOSTONE: deeply weathered dark yellowish orange dolostone, some med gray	
180			DOLOSTONE: med gray to med dark gray, very competent, thin fractures at 186' and 199', tr pyrite at 195'	
	15 gpm			
190				Bentonite chip backfill, 167'-361'
200				
	15 gpm			
210				
220			DOLOSTONE: med light gray interbedded w/ dark greenish gray (5 G 4/1), shaley texture	
	15 gpm			
230				
			DOLOSTONE: med gray to med light gray, competent	
240				
	15 gpm			
250				
260				
	15 gpm			



DEPTH FEET	BLOWN YIELD (GPM)	VOC (ppm)	LITHOLOGY	GRAPHIC	DEPTH FEET	WELL CONSTRUCTION	WELL CONSTRUCTION DETAILS
270					270		
280	15 gpm				280		6" dia. air rotary borehole, 98'-361'
290					290		
300	15 gpm				300		
310			DOLOSTONE: med dark gray, trace of calcite veining from 320' to 325', competent		310		
320	15 gpm				320		Bentonite chip backfill, 167'-361'
330					330		
340	15 gpm				340		
350					350		
360	15 gpm				360		Total depth: 361 ft

GROUNDWATER SCIENCES CORPORATION

GEOLOGIC LOG: SRMW-10S

Page 1 of 1

PROJECT INFORMATION

PROJECT:	*Shenandoah Alternative Water Supply*
SITE LOCATION:	*Town of East Fishkill, Dutchess Co., NY*
JOB NO.:	*01003.11.0105*
LOGGED BY:	*E. Stoner & J. Taylor*
DATES DRILLED:	*1/22/03*

DRILLING INFORMATION

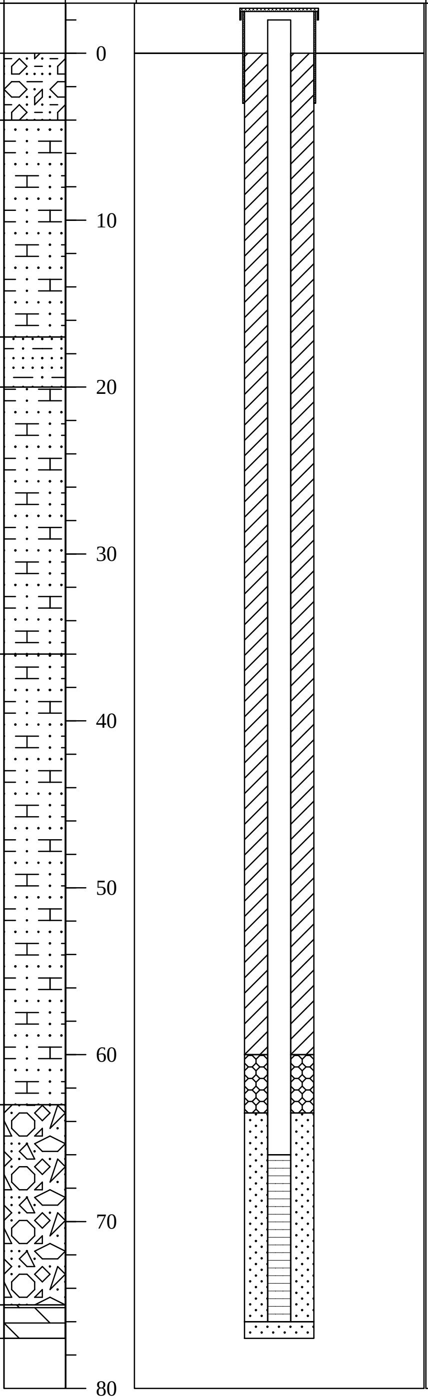
DRILLING CO.:	*Eichelbergers Inc.*
DRILLER:	*C. Brenneman*
RIG TYPE:	*Schramm*
DRILLING METHOD:	*Air Rotary*
DEVELOPMENT DATE:	*3/23/03*
LOCATION:	*S. of Jackson Road, approx. 10 ft S. of SRMW-10R*

NOTES: Well completed as a 2" dia. piezometer
SWL = 37.18' below casing rim, 1/24/03
Top of casing elevation: 357.78 ft amsl

SURFACE ELEVATION: 355.56 ft amsl

NORTHING: 982731.725 EASTING: 688182.874

DEPTH FEET	CUM. BLOWN YIELD	VOC (ppm)	LITHOLOGY
0			SILT, SAND & GRAVEL: dark yellowish brown
			CLAY & SILT
10			
			SAND & SILT: v. fine sand with silt and clay
20			CLAY & SILT: pred. silty clay
30			
			CLAY & SILT: med gray clay, some silt, tr. fine gravel and vc sand, increasing gravel below 59'
40			
50			
60			
			GRAVEL: subangular dolostone gravel
70			
			DOLOSTONE: gray, competent
80			



WELL CONSTRUCTION DETAILS

- 6" steel locking well cap
- 6" dia. steel casing with driveshoe, +2.5' to 3'
- 2" dia.sch 40 PVC riser pipe, +2.25 to 66'
- 6" dia. borehole, 0 to 77'
- Bentonite slurry annular seal, 0' to 60'
- Bentonite chip annular seal, 60' to 63.5'
- #0 sand, 63.5' to 77'
- 2" dia. 10-slot PVC screen, 66' to 76'

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GROUNDWATER SCIENCES CORPORATION

GEOLOGIC LOG: SRMW-11R

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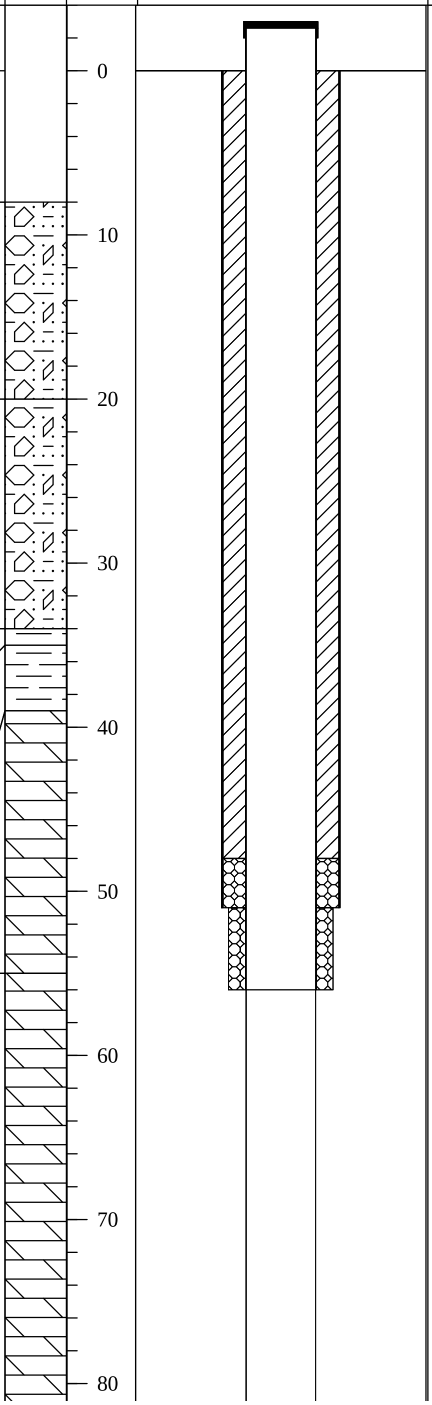
PROJECT INFORMATION		DRILLING INFORMATION	
PROJECT:	*Shenandoah Road RI*	DRILLING CO.:	*Eichelbergers, Inc.*
SITE LOCATION:	*Town of East Fishkill, Dutchess Co., NY*	DRILLER:	*Carey Knaub*
JOB NO.:	*01003.11.0105*	RIG TYPE:	*IR T4*
LOGGED BY:	*B. Titone / E. Stoner*	DRILLING METHOD:	*Air Rotary*
		DEVELOPMENT DATE:	*4/4/2007*
DATES DRILLED:	*02/21/07 - 03/02/07*	LOCATION:	*Townsend Road*

NOTES: SWL: 9.82' below TOC, 4/25/07
TOC elevation: 309.41 ft amsl
FLUTe system installed July 2007

SURFACE ELEVATION: 306.37
NORTHING: 984975.07 EASTING: 687159.73

DEPTH FEET	CUM. BLOWN YIELD	VOC (ppm)	LITHOLOGY
0			FILL: Item 4 surface fill
10			SILT, SAND & GRAVEL: dark yellowish brown, gravel of various lithologies
20			SILT, SAND & GRAVEL: dark yellowish brown to pale yellowish brown, heavy gravel/granules 32'-34'
30			
			SHALE: weathered shale
			SHALE: dark gray, layered, slightly slatey/phyllitic, micro layers of pyrite on bedding surfaces. occasional pyrite bands,healed fractures, secondary mineralization of quartz/calcite, graphite on surfaces
40			
			DOLOSTONE: light gray to medium gray, competent, healed secondary fractures, especially around 50' - 55'
50			
	0 gpm	0	DOLOSTONE: light to medium gray, occasional color variations, some phyllitic layers, traces pyrite, fractures @ 100.5', 113.5', and 124'-125'
60			
70	0 gpm	0	
80			



WELL CONSTRUCTION DETAILS

6" locking well cap

10" dia steel casing with STRADEX drive shoe, +1 - 51'

6" dia. steel casing with drive shoe and centralizers, +3 - 56'

Bentonite slurry 9"x6" annular seal, 1' - 48'

Bentonite chip 9"x6" annular seal, 48' - 56'

9" dia. air rotary borehole, 51' - 56'

6" dia. air rotary borehole, 56' - 500'

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GROUNDWATER SCIENCES CORPORATION

GEOLOGIC LOG: SRMW-11R

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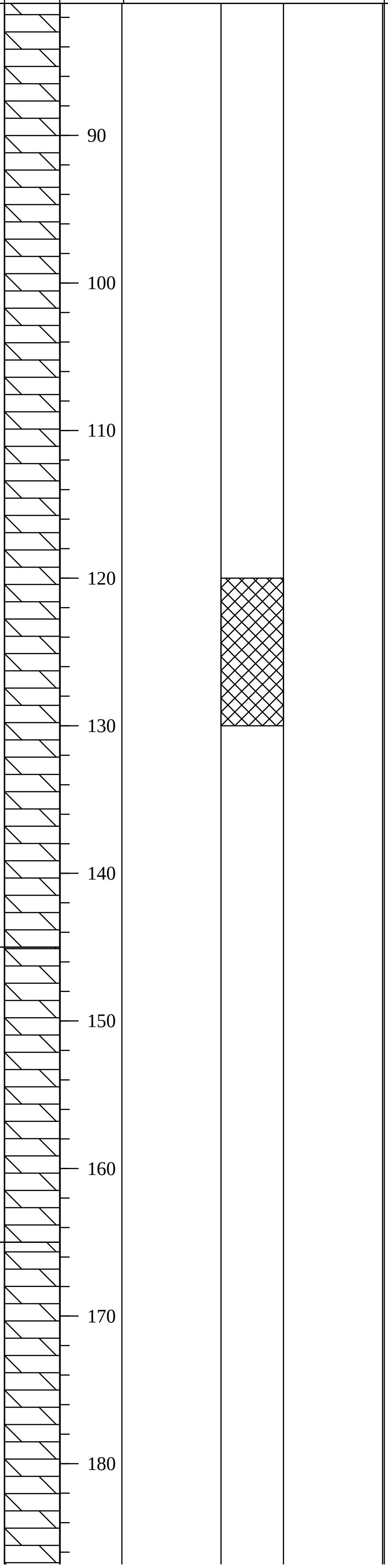
DEPTH FEET	BLOWN YIELD (GPM)	VOC (ppm)	LITHOLOGY	WELL CONSTRUCTION DETAILS
90				
	0 gpm	0		6" dia. air rotary borehole, 56' - 500'
100				
110				
120	trace gpm	0		FLUTe Sample Port ID# 120 sampling interval 120' - 130'
130				
140				
	8 gpm	0	DOLOSTONE: darky gray, shaley, trace pyrite, soft drilling	
150				
160				
			DOLOSTONE: light to medium gray, fractures @ 167', 197', and 221' (muddy)	
170	10-12 gpm	0		
180				



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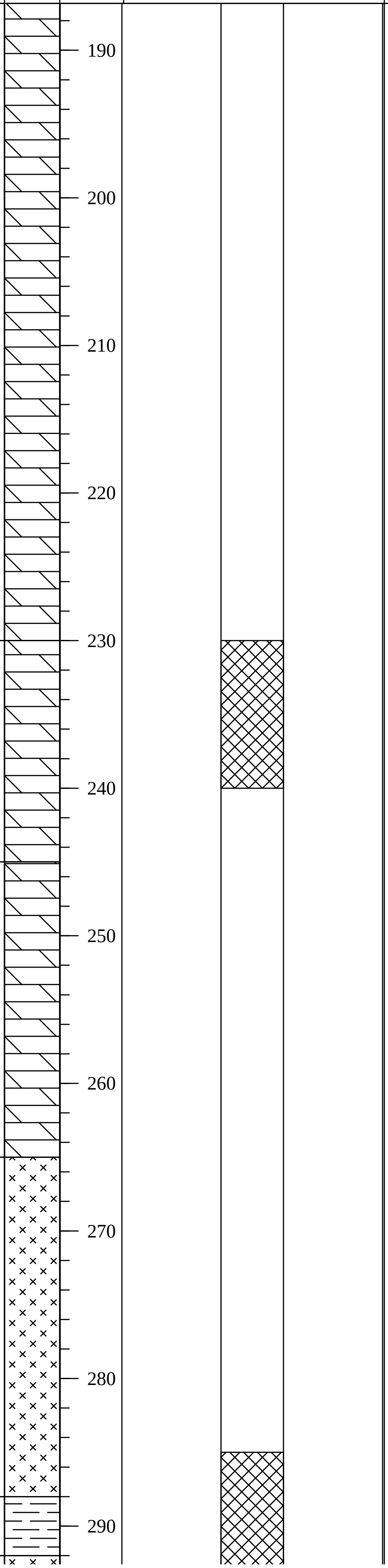
GEOLOGIC LOG: SRMW-11R

DEPTH FEET	BLOWN YIELD (GPM)	VOC (ppm)	LITHOLOGY	WELL CONSTRUCTION DETAILS
190				
	10-12 gpm	0		
200				6" dia. air rotary borehole, 56' - 500'
210				
220	12 gpm	0		
230			DOLOSTONE: high quartz content, dark gray to dark grayish brown, fracture @ 235'	FLUTe Sample Port ID# 230 sampling interval 230' - 240'
240				
	15 gpm	0	DOLOSTONE: high quartz content dolostone, medium gray to grayish black, some brownish black, pyritic	
250				
260				
			QUARTZITE: light olive gray, fractures @ 265'-268', weathered material @ 270', some translucent	
270	15 gpm	0		
280				
				FLUTe Sample Port ID# 285 sampling interval 285' - 305'
			ARGILLITE: dark gray to grayish black, phyllitic, weathered zone 292'-295' (muddy)	
290				



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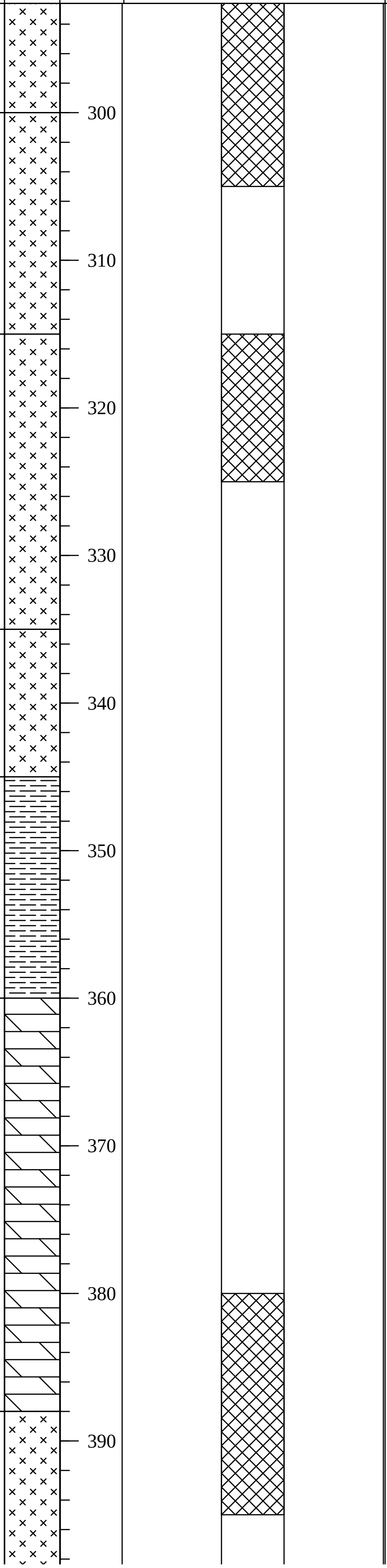
DEPTH FEET	BLOWN YIELD (GPM)	VOC (ppm)	LITHOLOGY	WELL CONSTRUCTION DETAILS
	16 gpm	0	QUARTZITE: light olive gray, weathered 295'-300'	
300			QUARTZITE: dusky yellow green to dk greenish gray, trace phyllitic material, occasional greenish black argillite, occasional translucent quartzite	
310				
			QUARTZITE: medium dark gray and dusky yellow green, occasional very dusky red purple quartzite, trace weathered material from 310'-320', fractured/heavily weathered zone 317' (muddy), soft 332'-335'	FLUTe Sample Port ID# 315 sampling interval 315' - 325'
320	18 gpm	0		
330				
	20 gpm	0	QUARTZITE: grayish olive green to greensh gray, shistose texture, weathered material 343'-345', shiny, trace dark red material	
340				
	20 gpm	0	PHYLLITE: grayish olive green to greenish gray, occasional pink dolostone crystals, occ. slightly dolomitic zones (shear zone)	
350				6" dia. air rotary borehole, 56' - 500'
360			DOLOSTONE: medium gray to grayish black, high quartz content, trace of white crystalline dolostone, trace of weathered material	
370	20-25 gpm	0		
380				FLUTe Sample Port ID# 380 sampling interval 380' - 395'
390			QUARTZITE: light olive gray, slightly foliated, trace pyrite, FRACTURE at 388'	
	30-40 gpm	0		



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GROUNDWATER SCIENCES CORPORATION

GEOLOGIC LOG: SRMW-11R

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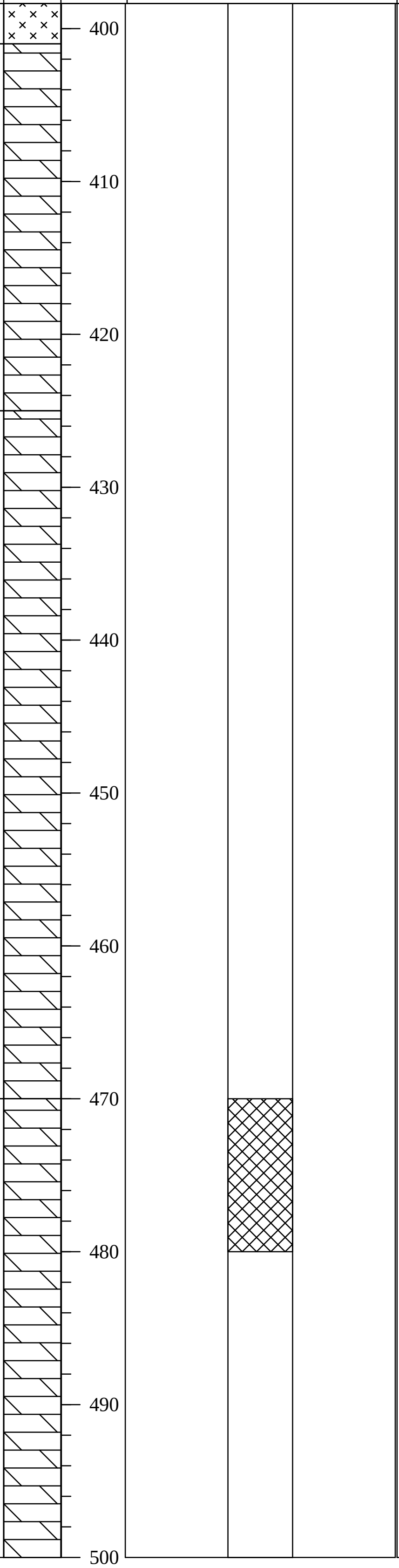
DEPTH FEET	BLOWN YIELD (GPM)	VOC (ppm)	LITHOLOGY	WELL CONSTRUCTION DETAILS
400			DOLOSTONE: medium gray, granular texture, trace pyrite, some high quartz content layers	
410				6" dia. air rotary borehole, 56' - 500'
420	30-40 gpm	0	DOLOSTONE: medium light gray to medium dark gray, trace pyrite, white dolostone-filled fractures, trace weathered material	
430				
440	50+ gpm	0		
450				
460				
470	50+ gpm	0	DOLOSTONE: light medium gray to brownish gray, trace pyrite, trace fracture skin, high quartz content	FLUTe Sample Port ID# 470 sampling interval 470' - 480'
480				
490				
500				



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GROUNDWATER SCIENCES CORPORATION

GEOLOGIC LOG: **SRMW-11S**

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PROJECT INFORMATION

PROJECT: ***Shenandoah Road RI***
SITE LOCATION: ***Town of East Fishkill, Dutchess Co., NY***
JOB NO.: ***01003.11.0105***
LOGGED BY: ***E. Stoner***
DATES DRILLED: ***6/12/07 - 6/13/07***

DRILLING INFORMATION

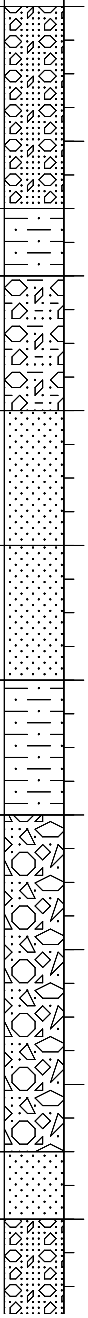
DRILLING CO.: ***Parratt-Wolff***
DRILLER: ***Jolann Price***
RIG TYPE: ***CME 45***
DRILLING METHOD: ***HSA***
DEVELOPMENT DATE: ***6/28/07***
LOCATION: ***Townsend Road, adjacent to SRMW-11R***

NOTES: SWL 9.74' below TOC - 6/29/07
TOC elevation: 305.43 ft amsl
Well not screened above water table to avoid siltation

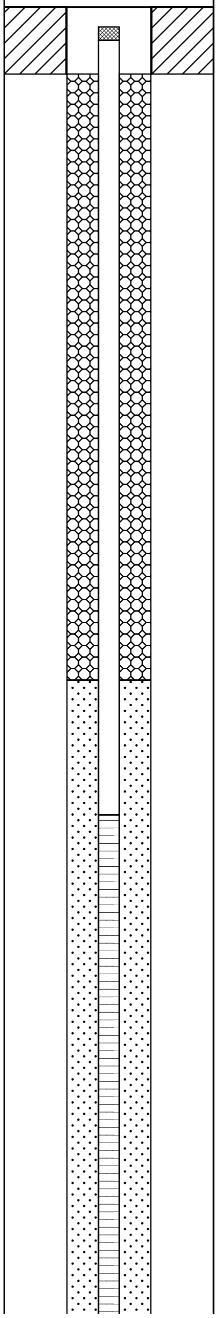
SURFACE ELEV.	306.37 ft amsl
EASTING	687165.58
NORTHING	984978.18

DEPTH FEET	BLOW COUNTS	VOC (ppm)	RECOV.	SAMP. #	SOIL DESCRIPTION
0	11 4 3 3	0	4"	1	SAND & GRAVEL: gravel, trace sand, trace silt
2	8 12 16 9	0	18"	2	SILT: silt and clay, trace sand, trace gravel
4	6 11 15 10	0	15"	3	SILT, SAND & GRAVEL: moderate brown (5YR 3/4), sand, silt and gravel, some mottling, moist
6	6 11 15 10	0	15"	4	SAND: dark yellowish brown (10YR 4/2), vf sand, trace silt, trace m sand, moist
8	7 7 10 14	0	18"	5	SAND: moderate yellowish brown to dusky yellowish brown (10YR 2/2), vf sand, trace gravel, mottled, wet
10	5 10 10 5	0	19"	6	SILT: silt, trace vf sand, mottled, wet to saturated at base
12	5 4 6 6	0	11"	7	GRAVEL: gravel/granules, trace c-vc sand, mixed lithologies, sr-r gravel, saturated, slightly coarsening down
14	7 8 8 10	0	16"	8	
16	7 8 9 11	0	22"	9	SAND: c-vc sand, few clay/silt laminations, saturated
18	44 25 20	0	20"	10	SAND & GRAVEL: m-c sand and gravel/granules, saturated

GRAPHIC



WELL CONSTRUCTION



WELL CONSTRUCTION DETAILS

6" three-bolt manhole assembly, plug and lock

2" dia. PVC riser (0.5' - 12')

Bentonite chip annular seal (1' - 10')

#00 grade sand pack (10' - 23')

2" dia.10-Slot PVC screen (12' - 22')

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GROUNDWATER SCIENCES CORPORATION

PROJECT: *Shenandoah Road RI*

GEOLOGIC LOG: SRMW-11S

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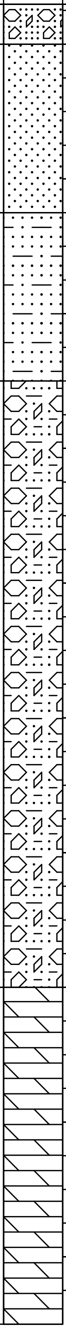
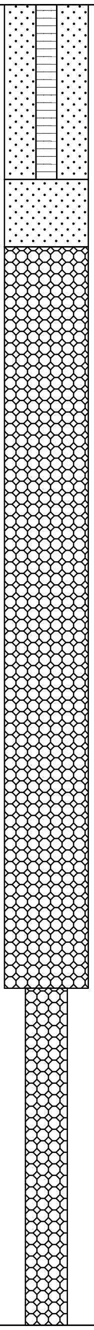
DEPTH FEET	BLOW COUNTS	VOC (ppm)	RECOV.	SAMP. #	SOIL DESCRIPTION
	20				
20	8 9 10 11	0	15"	11	SAND: m sand, occasional silt/clay laminations, saturated
22	15 17 20 20	0	20"	12	SAND & SILT: moderate yellowish brown sIlt, some vf sand, trace clay,
24	12 21 45 50	0	11"	13	SILT, SAND & GRAVEL: moderate yellowish brown, silt, sand and gravel, large cobbles, mixed lithologies, large gravel fragments often angular
26	100/0.5' augered to 28'	0	0	14	
28	55/0.5' augered to 30'	0	0	15	
30	36 40 50/0.5' augered	0	16"	16	
32	100/0.4' augered to 34'	0	3"	17	
34	100/0.1'	0	0	18	DOLOSTONE: dark gray (N3) dolomitic shale
36	HX Core	-	4.6'/5'	R1	
38					

GRAPHIC



DEPTH FEET

WELL CONSTRUCTION



WELL CONSTRUCTION DETAILS

2" dia.10-Slot PVC screen (12' - 22')

#00 grade sand pack (10' - 23')

Bentonite chip backfill (23' - 39')

8" dia. HSA borehole (0- - 34')

HX core hole (34' - 39')

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GROUNDWATER SCIENCES CORPORATION

GEOLOGIC LOG: SRMW-12RA/RB

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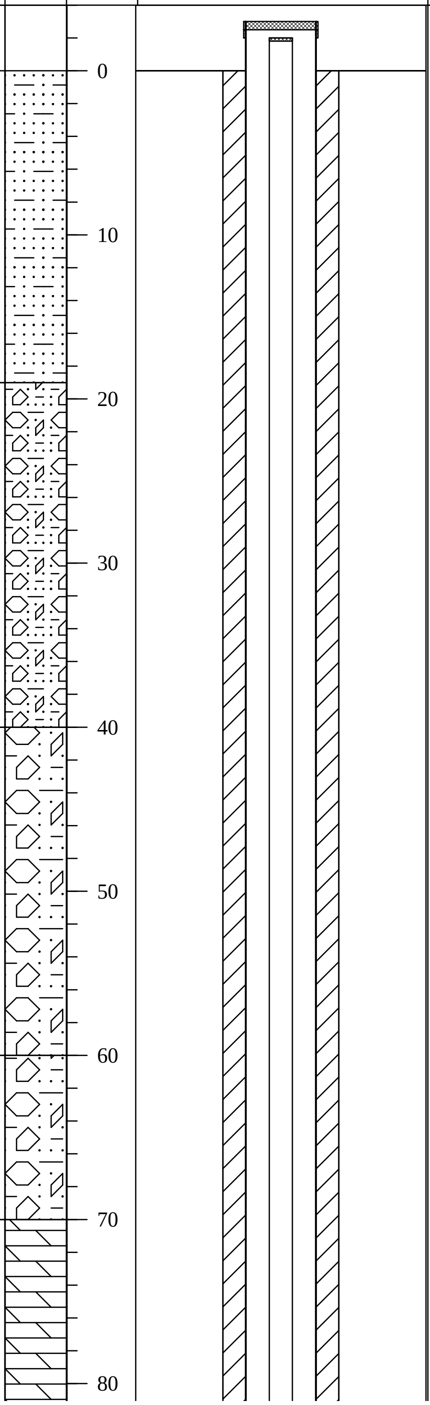
PROJECT INFORMATION		DRILLING INFORMATION	
PROJECT:	*Shenandoah Road RI*	DRILLING CO.:	*Eichelbergers, Inc.*
SITE LOCATION:	*Town of East Fishkill, Dutchess Co., NY*	DRILLER:	*C. Knaub / C. Brenneman*
JOB NO.:	*01003.11.105*	RIG TYPE:	*IR T4*
LOGGED BY:	*B. Titone / E. Stoner*	DRILLING METHOD:	*Air Rotary*
DATES DRILLED:	*11/8/06 - 11/17/06*	DEVELOPMENT DATE:	*3/30/2007*
		LOCATION:	*Townsend Road, east of Shenandoah Rd.*

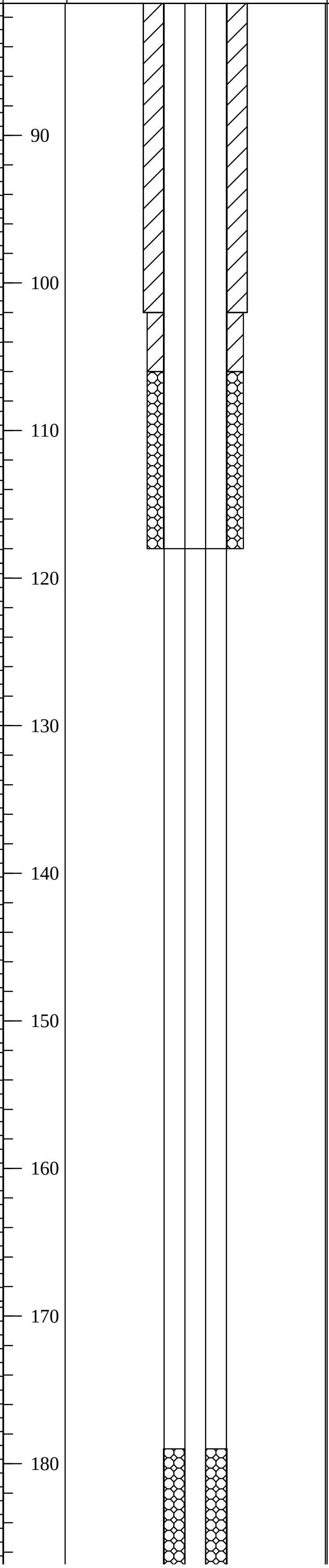
NOTES: SWL: 6/29/07, 12RB (6") - 5.88', 12RA (2") - Artesian
TOC elevation: 300.49 ft amsl (6"), 299.59 ft amsl (2")
2" well construction completed 6/26/07

SURFACE ELEVATION: 297.43 ft amsl
NORTHING: 984624.03 EASTING: 686118.93



DEPTH FEET	CUM. BLOWN YIELD	VOC (ppm)	LITHOLOGY	GRAPHIC	DEPTH FEET	WELL CONSTRUCTION	WELL CONSTRUCTION DETAILS
0			SAND & SILT: occasional fine gravel zones, wet-saturated at bottom		0		6" locking well cap 2" well seal
10					10		10" dia steel casing with STRADEX drive shoe, +1 - 102'
20			SILT, SAND & GRAVEL: dark yellowish orange (10YR 6/6) sr-r gravel		20		Bentonite slurry 10"x6" annular seal, 1' - 102'
30					30		
40			SILT & GRAVEL: trace sand and cobbles, dark yellowish orange, gravel primarily dolostone		40		6" dia. steel casing with drive shoe and centralizers, +3 - 118'
50					50		Open 2"x6" annulus, 0-179'
60			SILT & GRAVEL: some cobbles/boulders, trace sand, higher gravel content, olive gray (5Y 4/1)		60		
70			DOLOSTONE: medium bluish gray (5B 5/1) heavliy fractured, trace weathered material some dark gray layers		70		2" dia. PVC casing +2' to 250'
80					80		

BLOWN YIELD (GPM)	VOC (ppm)	LITHOLOGY
10 gpm	0	DOLOSTONE: medium bluish gray, occasional phyllitic layers, weathered material in 108'-112' zone
		DOLOSTONE: medium gray (N5) to medium bluish gray, quartzitic, phyllitic layers/laminations present, gray clay in fracture @ 125'
		DOLOSTONE: medium gray, quartzitic brown/orange clay in fracture @ 136', soft drilling 124'-144'
4 gpm	0	DOLOSTONE: fractured dark gray dolostone, some dark yellowish brown (10YR 4/2) to dark yellowish orange (10YR 6/6) material, voidfrom 144.5'-150'
		DOLOSTONE: medium gray, occasional phyllitic zones
18 gpm	0	DOLOSTONE: medium gray, some white/light gray, fine veins, healed fractures



WELL CONSTRUCTION DETAILS

Bentonite slurry 10"x6" annular seal, 1' - 102'

6" dia. steel casing with drive shoe and centralizers, +3 - 118'

Bentonite slurry 9.25"x6" annular seal, 102' - 106'

9.25" dia. air rotary borehole, 102' - 118'

Bentonite chip 9.25"x6" annular seal, 106' - 118'

Open 2"x6" annulus, 0-179'

2" dia. PVC casing +2' to 250'

Partial annular obstruction at 150'

6" dia. air rotary borehole, 118' - 500'

Bentonite chip 6"x2" annular seal, 179' - 247'

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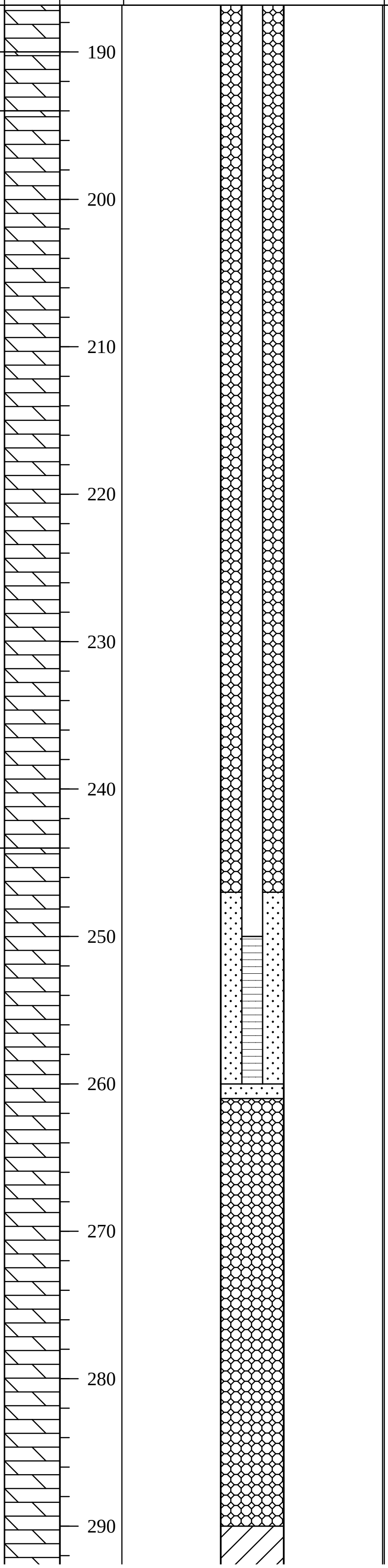
GROUNDWATER SCIENCES CORPORATION

GEOLOGIC LOG: SRMW-12RA/RB

DEPTH FEET	BLOWN YIELD (GPM)	VOC (ppm)	LITHOLOGY	WELL CONSTRUCTION DETAILS
190			DOLOSTONE: medium gray to dark gray, pyrite	
	18 gpm	0	DOLOSTONE: medium gray, occasional light/dark zones, occ. pyritic zones	
200				
210				6" dia. air rotary borehole, 118' - 500'
220	18 gpm	0		
230				Bentonite chip 6"x2" annular seal, 179' - 247'
240				
	18 gpm	0	DOLOSTONE: medium gray, occasional light gray, trace pyrite, occasional more pyritic zones, fractures @ 253' and 260'	
250				# 2 grade sand pack, 247' - 261'
				2" dia. 10 Slot PVC screen 250' - 260'
260				
270	25-30 gpm	0		
				Bentonite chip backfill, 261' - 290'
280				
290				Bentonite slurry backfill, 290' - 500'



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DEPTH FEET	BLOWN YIELD (GPM)	VOC (ppm)	LITHOLOGY	WELL CONSTRUCTION DETAILS
	25-30 gpm	0	DOLOSTONE: white (N9) to medium gray, trace pyrite	
300			DOLOSTONE: light gray (N7)	
310				Bentonite slurry backfill, 290' - 500'
320	25-30 gpm	0	DOLOSTONE: medium gray, slightly bluish gray	
330				
340				6" dia. air rotary borehole, 118' - 500'
	25-30 gpm	0	DOLOSTONE: medium dark gray to medium light gray (N4-N6)	
350				
360				
370	25-30 gpm	0	DOLOSTONE: medium gray to medium dark gray (N5 to N4)	
380				
390				
	25-30 gpm	0	DOLOSTONE: medium dark gray to dark gray (N4 to N3)	

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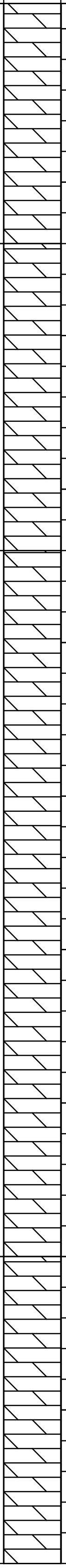
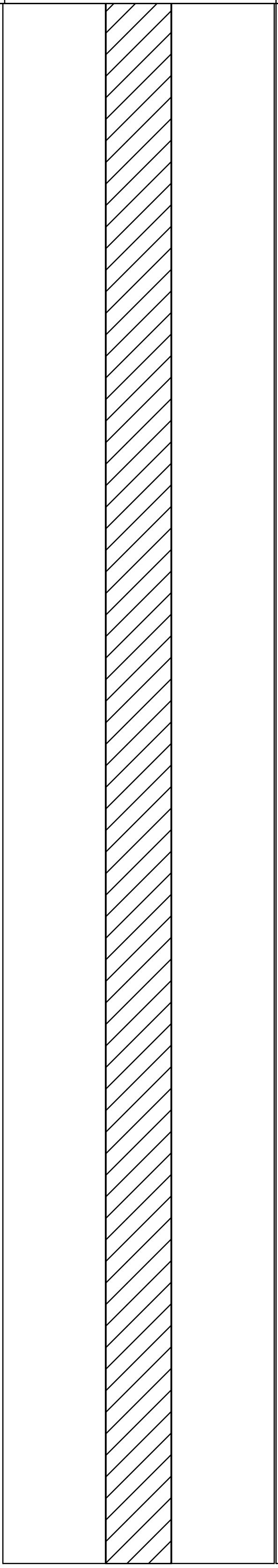
DEPTH FEET	BLOWN YIELD (GPM)	VOC (ppm)	LITHOLOGY	WELL CONSTRUCTION DETAILS
400				
410				
	25-30 gpm	0	DOLOSTONE: medium dark gray to dark gray (N4 to N3)	
420				
430				6" dia. air rotary borehole, 118' - 500'
	25-30 gpm	0	DOLOSTONE: medium dark gray, pyrite common but in thin layers	
440				
450				
	25-30 gpm	0		
460				
470				-470Bentonite slurry backfill, 290' - 500'
	25-30 gpm	0		
480			DOLOSTONE: medium gray, trace pyrite, thin white veins	
490				
	25-30 gpm	0		
	25-30 gpm			
500				

GRAPHIC



WELL CONSTRUCTION



PROJECT INFORMATION		DRILLING INFORMATION	
PROJECT:	***Shenandoah Road RI***	DRILLING CO.:	***Eichelbergers, Inc.***
SITE LOCATION:	***Town of East Fishkill, Dutchess Co., NY***	DRILLER:	***Chris Brenneman***
JOB NO.:	***01003.11.0105***	RIG TYPE:	***Shramm 450***
LOGGED BY:	***B. Titone / E. Stoner***	DRILLING METHOD:	***Air Rotary***
		DEVELOPMENT DATE:	***6/28/07 - 7/13/07***
DATES DRILLED:	***05/30/07 - 06/06/07***	LOCATION:	***Townsend Road***

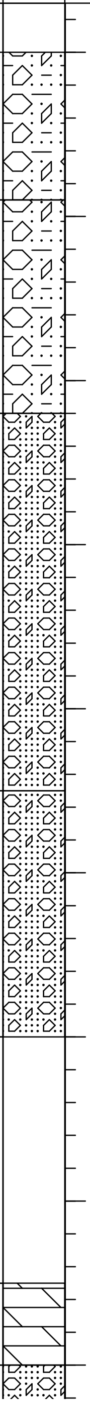
NOTES: SWL: 4.74' below TOC, 6/29/07
TOC elevation: 300.49 ft amsl (6"), 300.49 ft amsl (2")
12RC - 6x2" annulus, 12RD - 2" PVC built 9/26/07

SURFACE ELEVATION: 297.23 ft amsl

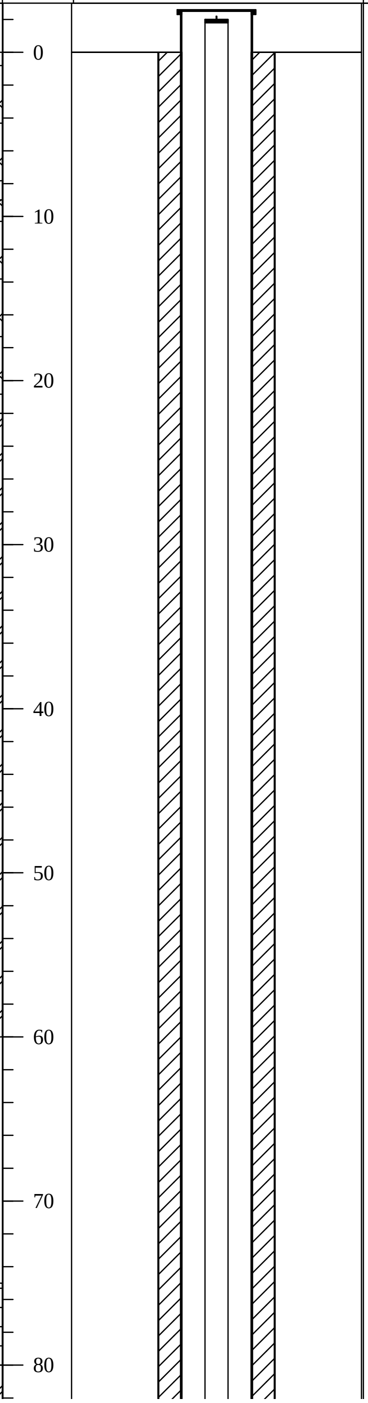
NORTHING: 984624.03 EASTING: 686118.93

DEPTH FEET	CUM. BLOWN YIELD	VOC (ppm)	LITHOLOGY
0			SILT, SAND & GRAVEL: dark yellowish brown (10YR 4/2) silt and gravel, subangular to subround, little sand, moist
10			SILT, SAND & GRAVEL: dark yellowish brown silt, little gravel, trace sand, trace clay, moist
20			SAND & GRAVEL: dark yellowish brown (10YR 4/2) gravel (granules), some silt, little sand, subround
30			
40			SAND & GRAVEL: pale yellowish brown (10YR 6/2) gravel/granules, little silt, trace sand, angular/subangular
50			
60			SILT & GRAVEL: gravel/granules and silt, trace sand, subangular to subround
70			DOLOSTONE: boulder, medium gray (N5)
80			SAND & GRAVEL: gravel and silt (10YR 6/2)

GRAPHIC



DEPTH FEET



WELL CONSTRUCTION

WELL CONSTRUCTION DETAILS

6" locking well cap

10" dia steel casing with STRADEX drive shoe, +1 - 96'

Bentonite slurry 10"x6" annular seal, 0' - 96'

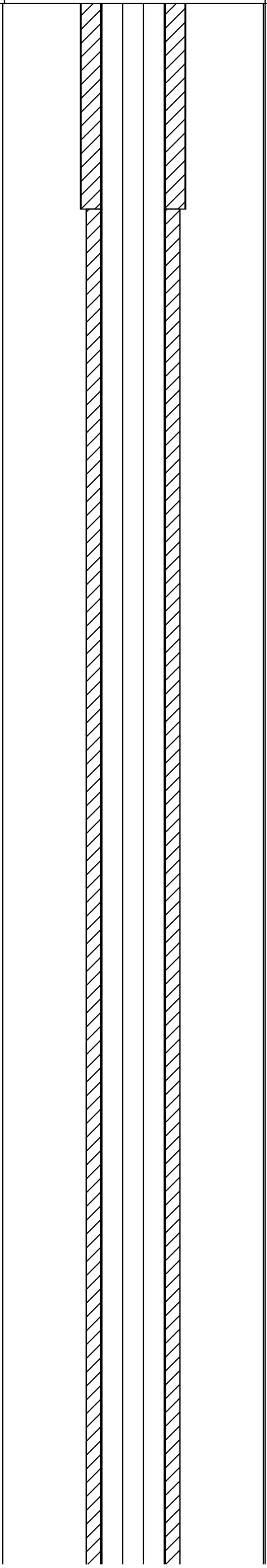
6" dia. steel casing with drive shoe and centralizers, +3 - 270'

2" dia. sch 40 PVC riser pipe, 2.5' - 388'

Open 2" x 6" annulus, 0' - 320'

DEPTH FEET	BLOWN YIELD (GPM)	VOC (ppm)	LITHOLOGY
			subround to subangular
			DOLOSTONE: boulder, medium gray, some light bands
90			SAND & GRAVEL: various gravel and silt (10YR 6/2), subround to subangular
			DOLOSTONE: light to medium gray (N3 with N7-N9 bands), banded, some phyllitic zones, thin calcite veins at 95'
100			DOLOSTONE: medium gray (N4), slightly phyllitic, very light gray (N8) vein material
110			DOLOSTONE: light medium gray (N5) slightly phyllitic with thin moderate brown (5YR 4/4) sandstone layers, some very light grayvein material, thinly layered, more phyllitic with depth, fracture at 130'
120			
130			DOLOSTONE: light medium gray slightly phyllitic, thin and less frequent moderate brown sandstone layers
140			DOLOSTONE: light medium gray (N6-N4), thinly bedded, alternating color, phyllitic texture 149'-154'
150			DOLOSTONE: dark gray (N3), some medium dark to light gray (N4-N7) thicker color bands, trace pyrite, fracture at 161'
160			DOLOSTONE: dark medium gray (N3), some phyllitic layers, trace pyrite, consistent color and texture, soft zone at 181'
170			
180			

WELL CONSTRUCTION



WELL CONSTRUCTION DETAILS

10" dia steel casing with STRADEX drive shoe, +1 - 96'

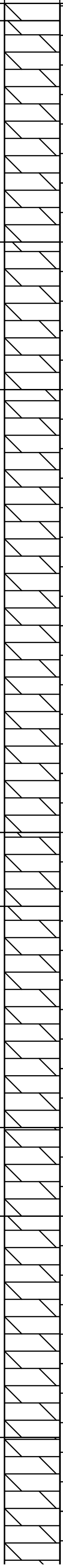
9" dia. air rotary borehole, 96' - 270'

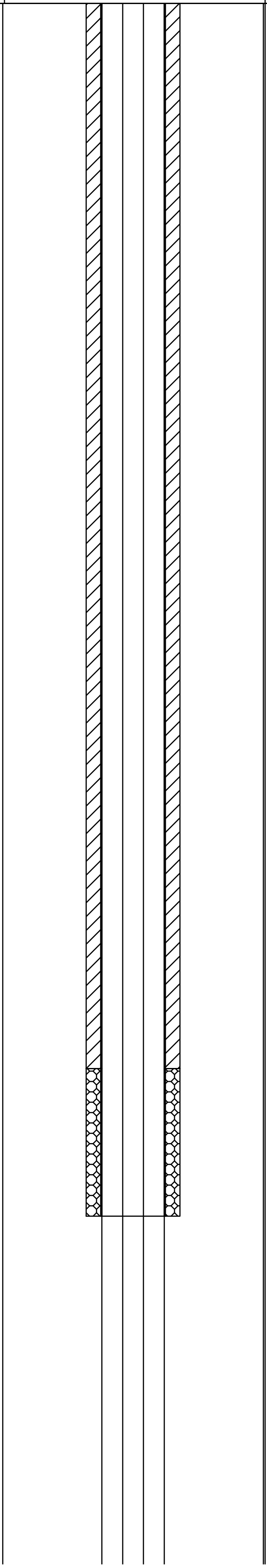
Bentonite slurry 9"x6" annular seal, 96' - 260'

6" dia. steel casing with drive shoe and centralizers, +3 - 270'

2" dia. sch 40 PVC riser pipe, 2.5' - 388'

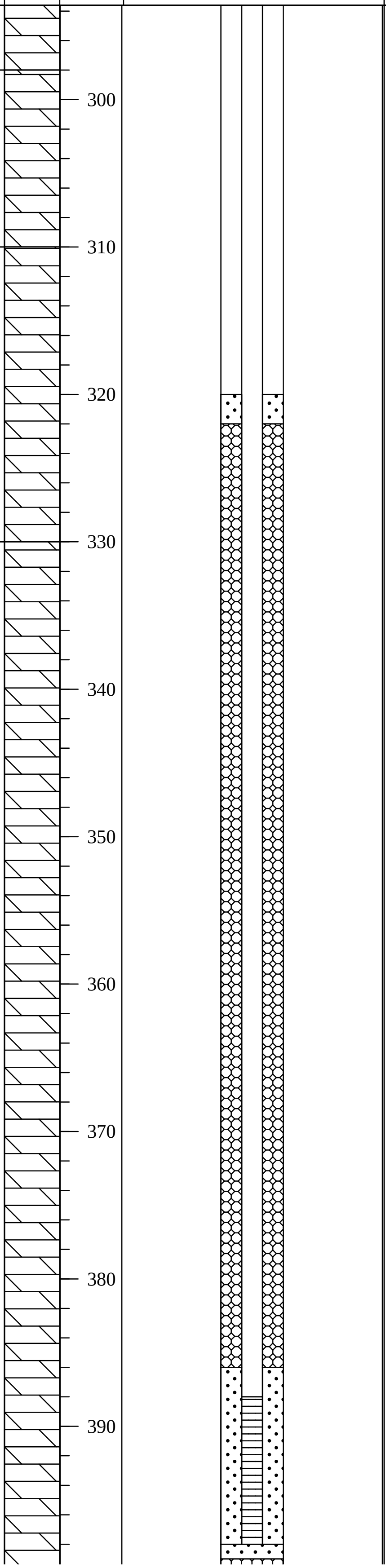
Open 2" x 6" annulus, 0' - 320'





DEPTH FEET	BLOWN YIELD (GPM)	VOC (ppm)	LITHOLOGY	WELL CONSTRUCTION DETAILS
190			DOLOSTONE: medium gray (N3-N6) with phyllitic layers, trace pyrite	
200				9" dia. air rotary borehole, 96' - 270'
			DOLOSTONE: medium gray (N4), with thin olive gray (5Y 4/1) phyllitic layers, trace pyrite	
210				
			DOLOSTONE: medium gray (ranging N3 to N6), somewhat thicker beds, less to no phyllitic layers, fracture near 239'	
220				Bentonite slurry 9"x6" annular seal, 96' - 260'
230				
240				6" dia. steel casing with drive shoe and centralizers, +3 - 270'
			DOLOSTONE: medium dark gray to light gray (N4 to N7), hard, thinly bedded	
250			DOLOSTONE: dark to medium light gray (N3-N6), light olive gray (5Y 6/1) phyllitic layers/sheens, trace pyrite, more olive grayafter 254', fracture/WBZ 253'-254'	
260				
			DOLOSTONE: light gray to medium gray (N7-N5) layered colors, trace pyrite	Bentonite chip 9"x6" annular seal, 260' - 270'
270			DOLOSTONE: medium gray (N5), hard, consistent	
280	0 gpm	0		Open 2" x 6" annulus, 0' - 320'
			DOLOSTONE: medium light gray to white (N6-N9), thinly layered, trace light olive gray phyllitic layers	
290				2" dia. sch 40 PVC riser pipe, 2.5' - 388'

DEPTH FEET	BLOWN YIELD (GPM)	VOC (ppm)	LITHOLOGY	WELL CONSTRUCTION DETAILS
300	0 gpm	0	DOLOSTONE: medium light gray (N6), hard, consistent	Open 2" x 6" annulus, 0' - 320'
310			DOLOSTONE: medium to medium darrk gray (N5-N4), hard, consistent, few lighter, darker layers	
320	0.5-1 gpm	0		choke sand, 320' - 322'
330			DOLOSTONE: medium gray (N4-N5), hard, consistent, few lighter, darker layers	
340	0.5-1 gpm	0		Bentonite chip 2"x6" annular seal, 322' - 386'
350				
360	0.5-1 gpm	0		2" dia. sch 40 PVC riser pipe, 2.5' - 388'
370				
380	0.5-1 gpm	0		
390				#1 grade sand pack, 386' - 399' 20-slot sch. 40 PVC screen, 388' - 398'

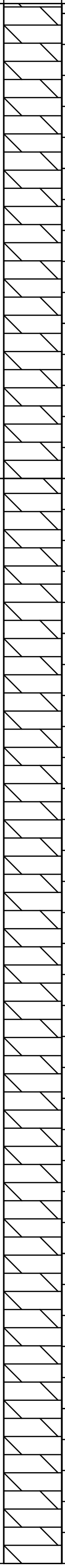


GROUNDWATER SCIENCES CORPORATION

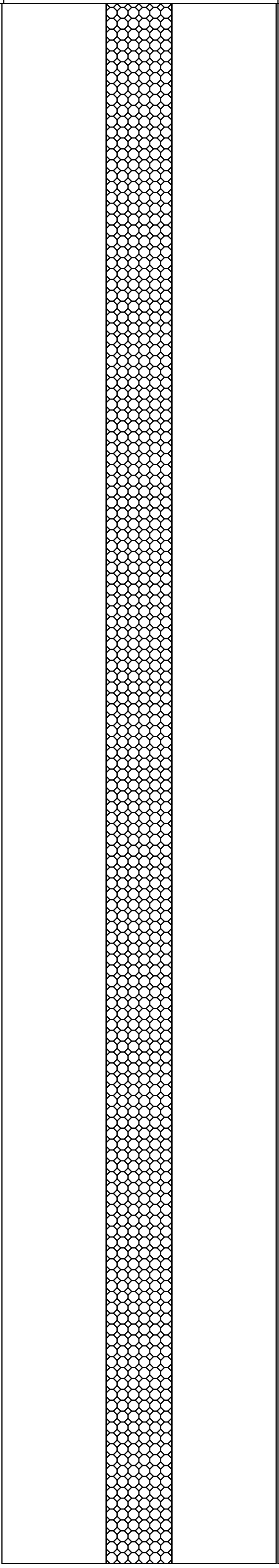
GEOLOGIC LOG: **SRMW-12RC/RD**

DEPTH FEET	BLOWN YIELD (GPM)	VOC (ppm)	LITHOLOGY	WELL CONSTRUCTION DETAILS
400	0.5-1 gpm	0		
410				
420	0.5-1 gpm	0		6' dia. air rotary borehole, 270' - 500'
430			DOLOSTONE: medium gray (N4-N5), hard, consistent, few lighter, darker layers	
440	0.5-1 gpm	0		
450				
460	0.5-1 gpm	0		Bentonite chip backfill, 399' - 500'
470				
480	0.5-1 gpm	0		
490	0.5-1 gpm	0		
500				

GRAPHIC



WELL CONSTRUCTION



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GROUNDWATER SCIENCES CORPORATION

GEOLOGIC LOG: SRMW-12S

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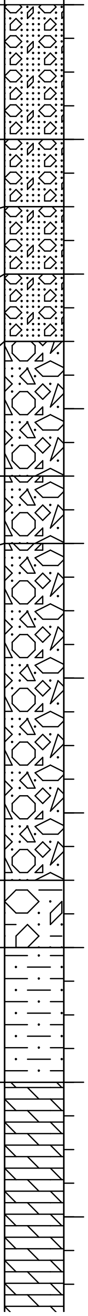
PROJECT INFORMATION		DRILLING INFORMATION	
PROJECT:	*Shenandoah Road RI*	DRILLING CO.:	*Parratt Wolff*
SITE LOCATION:	*Town of East Fishkill, Dutchess Co., NY*	DRILLER:	*Jolann Price*
JOB NO.:	*01003.11.0105*	RIG TYPE:	*CME 45*
LOGGED BY:	*B. Titone / E. Stoner*	DRILLING METHOD:	*HSA/Mud Rotary*
DATES DRILLED:	*6/13/07 - 6/14/-07*	DEVELOPMENT DATE:	*6/28/07*
		LOCATION:	*Townsend Road, adjacent to SRMW-12RA/RB*

NOTES: SWL: 4.74' below TOC, 6/29/07
TOC elevation: 297.31 ft amsl

SURFACE ELEV. 297.56 ft amsl
EASTING 686127.38
NORTHING 984626.01

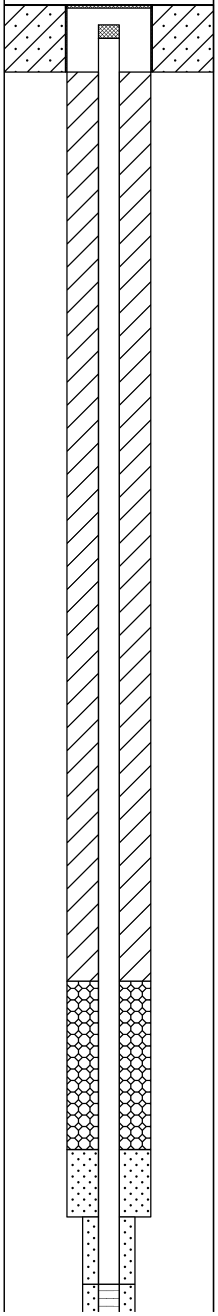
DEPTH FEET	BLOW COUNTS	VOC (ppm)	RECOV.	SAMP. #	SOIL DESCRIPTION
0	5 7 9 20	0	14"	1	SAND & GRAVEL: dk yell. brown (10YR 4/2) gravel, little m-c sand, trace silt, angular, 1.5' - 2' is moderate brown more silt, traceclay, moist, organic rich
2	18 18 10 16	0	12"	2	SAND & GRAVEL: moderate brown (5YR 4/4) gravel, little sand, little silt, trace clay, moist SAND & GRAVEL: dk yell. brown f sand, some c gravel, wet, c sand prominant toward bottom
4	21 31 36 31	0	18"	3	SAND & GRAVEL: mod. brown (5yR 3/4) gravel, little silt, little m-c sand, moist, organics/roots/clay GRAVEL: dk yell. brown f-c gravel, little silt, little m sand, moist, occasional cobble, 3" silt, trace sand at bottom
6	26 21 20 20	0	11"	4	GRAVEL: dk yell. brown m-f gravel, subr, little silt, trace sand, moist, 2" mod. yell. brown silt at bottom
8	29 15 12 12	0	15"	5	GRAVEL: gravel, some silt, trace sand, dense, moist to wet, dk greenish gray (5GY 4/1) at base
10	3 8 13 10	0	10"	6	
12	10 12 10 12	0	12"	7	SILT & GRAVEL: greenish gray (5GY 6/1), silt and gravel, trace sand, wet
14	9 9 13 26	0	10"	8	SILT: trace gravel, some fine laminations, 1/4" vf sand lens at base, grayish brown (5YR 3/2), wet
16	70/0.4' rollerbit to 18 ft	0	5"	9	DOLOSTONE BOULDER: medium gray (N5)
18	rollerbit to 20 ft	0	0	--	

GRAPHIC



DEPTH FEET: 0, 2, 4, 6, 8, 10, 12, 14, 16, 18

WELL CONSTRUCTION



WELL CONSTRUCTION DETAILS

9" flushmounted manhole w/ sealing cap and lock

8" dia. HSA borehole (0 - 18')

Bentonite slurry annular seal (0' - 14.5')

2" dia. PVC riser (0.5' - 12')

Bentonite chip annular seal (14.5' - 17')

#00 grade sand pack (17' - 19')

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GROUNDWATER SCIENCES CORPORATION

GEOLOGIC LOG: SRMW-12S

PROJECT: ***Shenandoah Road RI***

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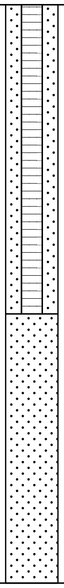

DEPTH FEET	BLOW COUNTS	VOC (ppm)	RECOV.	SAMP. #	SOIL DESCRIPTION	GRAPHIC	DEPTH FEET	WELL CONSTRUCTION	WELL CONSTRUCTION DETAILS
20	3 3 3 5	0	1"	10	SAND: vc sand, little f gravel, saturated, mixed lithologies		20		5" dia. mud rotary hole (18' - 28')
22	7 12 28 24	0	20"	11			22		2" dia. 10-Slot PVC screen (19' - 24')
24	14 18 16 24	0	14"	12	SAND: dark yellowish brown, vf sand, little silt, trace gravel, saurated		24		Collapsed sand formation (19' - 25')
26	12 17 28 33	0	15"	13	SAND: dark yellowish brown, vf-f and, saturated, 1.75" cobble at base, occasional silt/clay laminations		26		
28							28		

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GROUNDWATER SCIENCES CORPORATION

GEOLOGIC LOG: **SRMW-12SA**

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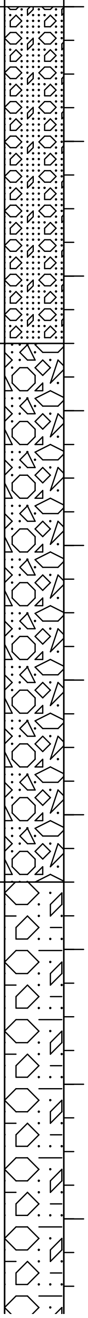
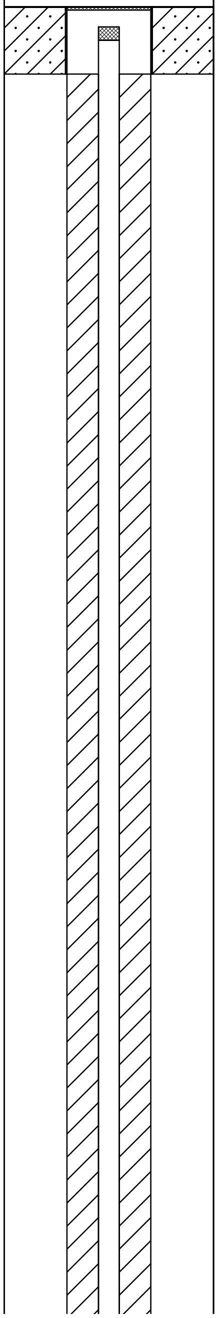
PROJECT INFORMATION		DRILLING INFORMATION	
PROJECT:	***Shenandoah Road RI***	DRILLING CO.:	***Parratt Wolff***
SITE LOCATION:	***Town of East Fishkill, Dutchess Co., NY***	DRILLER:	***Jolann Price***
JOB NO.:	***01003.11.105***	RIG TYPE:	***CME 45***
LOGGED BY:	***B. Titone / E. Stoner***	DRILLING METHOD:	***HSA/Mud Rotary***
DATES DRILLED:	***6/13/07 - 6/14/07***	DEVELOPMENT DATE:	***6/28/07***
		LOCATION:	***Townsend Road***

NOTES:	SWL: 5.13' below TOC, 6/29/07 TOC elevation: 297.49 ft amsl	SURFACE ELEV.	297.82 ft amsl
		EASTING	686134.75
		NORTHING	984627.42

DEPTH FEET	BLOW COUNTS	VOC (ppm)	RECOV.	SAMP. #	SOIL DESCRIPTION	GRAPHIC	DEPTH FEET	WELL CONSTRUCTION	WELL CONSTRUCTION DETAILS
0					SAND & GRAVEL: Augered to 40' (See SRMW-12S)		0		6" single-bolt manhole assembly, plug and lock
2							2		
4	Augered to 40'						4		
					GRAVEL				
6							6		8" dia. HSA borehole (0 - 40')
8							8		
10							10		
12							12		Bentonite slurry annular seal (0' - 27')
					SILT & GRAVEL				
14							14		
16							16		
									2" dia. PVC riser pipe (0.5' - 34')
18							18		

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GROUNDWATER SCIENCES CORPORATION

GEOLOGIC LOG: SRMW-12SA

PROJECT: ***Shenandoah Road RI***

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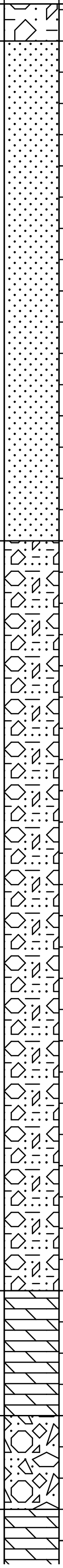

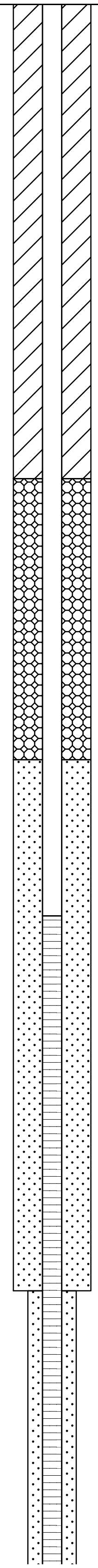

DEPTH FEET	BLOW COUNTS	VOC (ppm)	RECOV.	SAMP. #	SOIL DESCRIPTION	DEPTH FEET	WELL CONSTRUCTION DETAILS
20					SAND	20	
22						22	Bentonite slurry annular seal (0' - 27')
24						24	
26						26	2" dia. PVC riser pipe (0.5' - 34')
28	Augered to 40'				SILT, SAND & GRAVEL	28	
30						30	Bentonite chip annular seal (27' - 31.5')
32						32	
34						34	
36						36	2" 10-Slot PVC screen (34' - 49')
38						38	
40	50/0.1' rollerbit to 42'	0	0	1	DOLOSTONE BOULDER	40	#00 grade sand pack (31.5' - 49.5')
42	35 30 50/0.4' -	0	15"	2	GRAVEL: pale yellowish brown (10YR 6/2) gravel, little c-m sand, trace silt, (8") then light brown sand/granules grading to m-c sand trace silt, little gravel, wet DOLOSTONE BOULDER	42	5" dia. mud rotary hole (40' - 52')
44						44	

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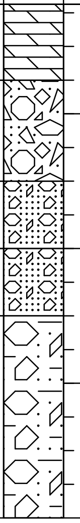
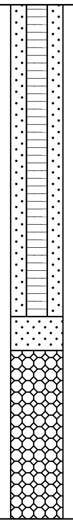
GROUNDWATER SCIENCES CORPORATION

GEOLOGIC LOG: SRMW-12SA

PROJECT: ***Shenandoah Road RI***

DEPTH FEET	BLOW COUNTS	VOC (ppm)	RECOV.	SAMP. #	SOIL DESCRIPTION	WELL CONSTRUCTION DETAILS
	rollerbit to 46' -	0	0	3	GRAVEL: gravel, little silt, trace sand, dense, moist, occasional cobble	
46	28 28 28 31	0	14"	4	SAND & GRAVEL: gravel, some sand, little silt, wet	#00 grade sand pack (31.5' - 49.5')
48	26 28 36 33	0	16"	5	SAND & GRAVEL: gravel/granules, some c-f sand, trace silt, wet SILT & GRAVEL: gravel and silt, trace sand, trace clay, dense, moist, occasional cobble	2" 10-Slot PVC screen (34' - 49')
50	30 65 50/0.4' -	0	16"	6		Bentonite chip backfill (49.5' - 52')
52						





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GROUNDWATER SCIENCES CORPORATION

***GEOLOGIC LOG:* SRMW-12SB**

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PROJECT INFORMATION

PROJECT: ***Shenandoah Road RI***
SITE LOCATION: ***Town of East Fishkill, Dutchess Co., NY***
JOB NO.: ***01003.11.0105***
LOGGED BY: ***B. Titone / E. Stoner***
DATES DRILLED: ***6/14/07 - 6/21/07***

DRILLING INFORMATION

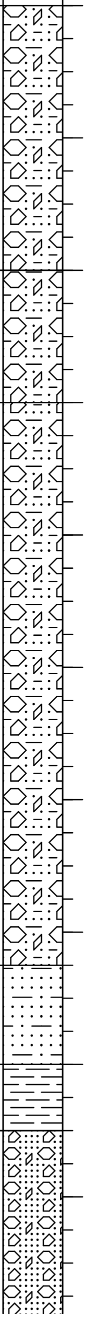
DRILLING CO.: ***Parratt Wolff***
DRILLER: ***Jolann Price***
RIG TYPE: ***CME 45***
DRILLING METHOD: ***HSA/Mud Rotary***
DEVELOPMENT DATE: ***6/21/07***
LOCATION: ***Townsend Road, adjacent to SRMW-12RA/RB***

NOTES: SWL: 8.88' below TOC, 6/29/07
TOC elevation: 297.83 ft amsl
3" Split Spoons except HX Core from 74' - 78', 84.5' - 94.5'

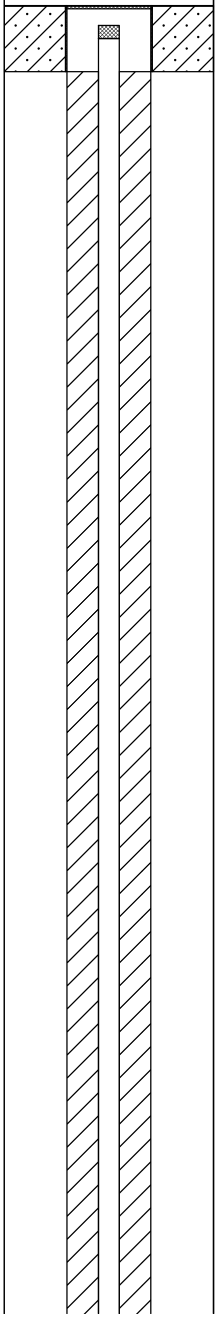
SURFACE ELEV. 298.22 ft amsl
EASTING 686141.62
NORTHING 984629.39

DEPTH FEET	BLOW COUNTS	VOC (ppm)	RECOV.	SAMP. #	SOIL DESCRIPTION	WELL CONSTRUCTION DETAILS
0	8 8 7 15	0	15"	1	SILT, SAND & GRAVEL: gravel, trace sand, trace silt	6" single-bolt manhole assembly, plug and lock
2	21 11 8 16	0	16"	2		
4	5 21 31 32	0	20"	3	SILT, SAND & GRAVEL: grayish brown (5YR 3/2) gravel, some silt, some sand, various lithologies, dense, moist	8" dia HSA borehole (0'- 35')
6	43 38 34 30	0	17"	4	SILT, SAND & GRAVEL: dk yell. brown (10YR 4/2) to dark greenish gray (5GY 4/1), gravel, some silt and sand, moist; 2" dense clay w/ littlevf gravel at 8'; more m sand at 10'	
8	15 22 13 12	0	19"	5		
10	22 23 20 22	0	12"	6		2" dia. PVC riser (0.5' - 68')
12	30 25 20 25	N/A	0	7		
14	10 9 9 10	0	18"	8	SAND & SILT: vf sand grading to silt with little clay at 15', trace f gravel and vc sand throughout, wet to saturated	Bentonite slurry annular seal (0' - 61.3')
16	13 12 13 15	0	22"	9	CLAY: clay, trace f sand, trace f gravel, grades from unit below SAND & GRAVEL: fine gravel, little vc sand, saturated to 18', then vc sand, little f gravel, mixed lithologies, saturated	
18	3 3 3	0	13"	10		

GRAPHIC



WELL CONSTRUCTION



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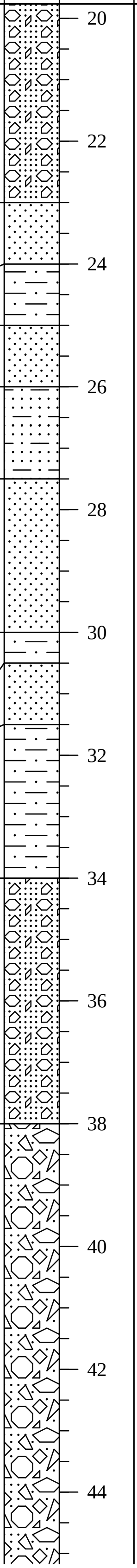
GROUNDWATER SCIENCES CORPORATION

GEOLOGIC LOG: SRMW-12SB

PROJECT: ***Shenandoah Road RI***

DEPTH FEET	BLOW COUNTS	VOC (ppm)	RECOV.	SAMP. #	SOIL DESCRIPTION	WELL CONSTRUCTION DETAILS
	7					
20	6 5 7 12	0	16"	11		
22	12 10 11 27	0	23"	12	SAND: sand, 1" c-vc; 1" silt, trace m sand; 3" f-m sand; vf sand w clay/silt laminations to 24', saturated	8" dia HSA borehole (0'- 35')
24	20 19 26 48	0	18"	13	SILT: grayish brown, silt, some vf sand, trace gravel, saturated SAND: grayish brown, f-m sand, well sorted, saturated	
26	19 31 41 50	0	20"	14	SAND & SILT: dk yell. brown, silt and vf sand, trace gravel, dense, saturated SAND: dk yell. brown, sand f to vf at base, trace silt/clay, saturated	
28	10 13 30 50	0	16"	15		Bentonite slurry annular seal (0' - 61.3')
30	19 22 20 20	0	18"	16	SILT: mod. yell. brown (10YR 5/4), silt, trace clay, saturated SAND: m sand, silt/clay laminations with vf sand, saturated SILT: mod. yell. brown, silt, little vc sand to 32' and little vf sand to 34', saturated; 0.5" m sand zones at 32.5' and 33'	
32	21 26 50/0.5' -	0	14"	17		
34	43 40 38 40	0	17"	18	SAND & GRAVEL: fine gravel and vc sand trace silt, saturated	2" dia. PVC riser (0.5' - 68')
36	27 27 34 36	0	14"	19		
38	49 28 30 35	0	18"	20	GRAVEL: dk yell. brown gravel, sr-r to a-sr at 40', trace silt, trace vc sand, 0.5", f sand layer at 42.5', dolostone cobblesthroughout	
40	42 50/0.2' rollerbit to 42'	0	3"	21		5" dia .mud rotary borehole (46'- 83')
42	60 24 26 18	0	17"	22		
44	60 46					

GRAPHIC



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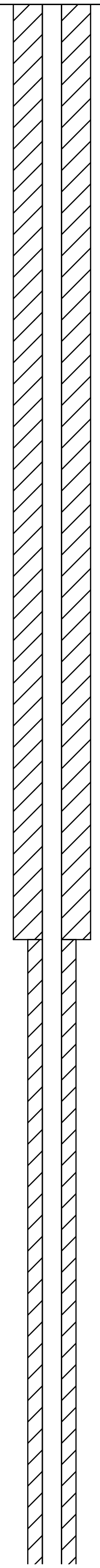

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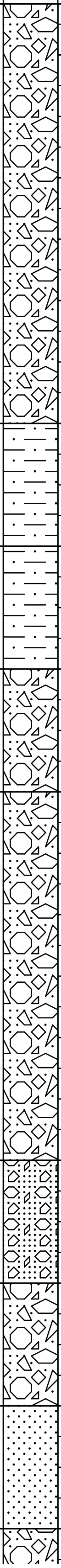
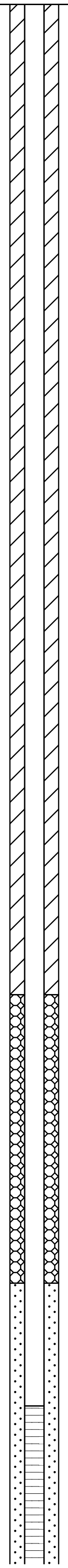
GROUNDWATER SCIENCES CORPORATION

GEOLOGIC LOG: SRMW-12SB

PROJECT: ***Shenandoah Road RI***





DEPTH FEET	BLOW COUNTS	VOC (ppm)	RECOV.	SAMP. #	SOIL DESCRIPTION	WELL CONSTRUCTION DETAILS
	48 50	0	14"	23		
46	100/0.5' rollerbit to 48'	0	1"	24		
48	100/0.4' rollerbit to 50'	N/A	0	25		5" dia .mud rotary borehole (46'- 83')
50	100/0.2' rollerbit to 52'	N/A	0	26		
52	19 12 48 42	0	2"	27	SILT: dk yell. brown, silt, trace vc sand, trace f gravel, moist	Bentonite slurry annular seal (0' - 61.3')
54	100/0.5' rollerbit to 56'	0	3"	38	SILT: silt, little gravel, trace c-vc sand, dense, moist, subangular gravel	
56	60 60 52 32	0	16"	29	GRAVEL: dusky brown (5YR 2/2), gravel, a-subr, little sand, trace silt, saturated, 1" f sand layer at base	
58	82/0.5' rollerbit to 60'	0	6"	30	GRAVEL: gravel and cobbles	2" dia. PVC riser (0.5' - 68')
60	100/0.4' rollerbit to 62'	N/A	0	31		
62	100/0.2' rollerbit to -	N/A	0	32		Bentonite chip annular seal (61.3' - 66')
64	64' rollerbit to 66'	0	5"	33	SAND & GRAVEL: dk yell. brown f sand, some m-c sand and gravel, suba, trace silt, broken rock pieces, wet to saturated,gravel/granules bottom 2"	
66	100/0.4' rollerbit to 68'	0	3"	34	GRAVEL: light olive gray (5Y 5/2) gravel, little f-c sand, little silt, saturated, subangular gravel	#00 grade sand pack (66' - 83.5')
68	100/0.2' rollerbit to 70'	0	1"	35	SAND: grayish brown m-f sand, some silt, trace gravel, wet	2" dia. 10-Slot PVC screen (68' - 83')
70	100/0.3'				GRAVEL: gravel/granules, sa-sr, little silt,	

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GROUNDWATER SCIENCES CORPORATION

GEOLOGIC LOG: SRMW-12SB

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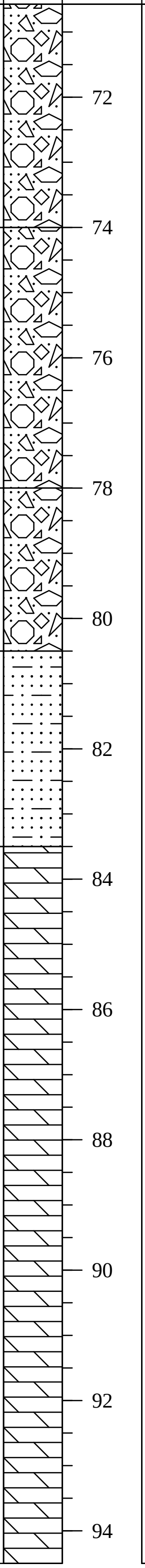
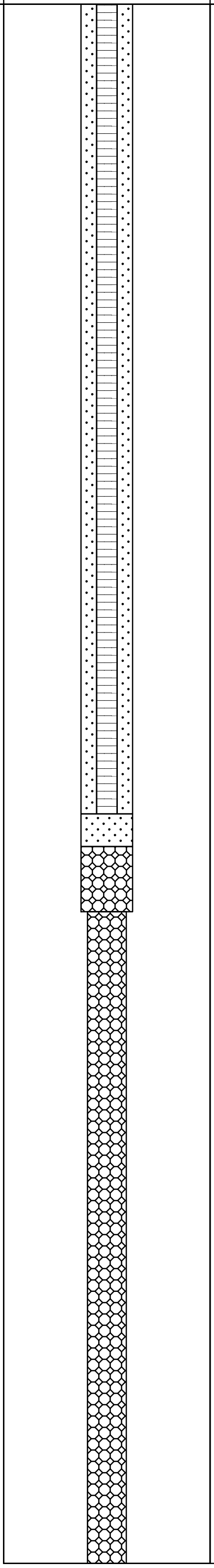
PROJECT: ***Shenandoah Road RI***

DEPTH FEET	BLOW COUNTS	VOC (ppm)	RECOV.	SAMP. #	SOIL DESCRIPTION
72	rollerbit to 72'	0	2"	36	
74	100/0.3' rollerbit to 74'	N/A	0	37	
76 78	HX Core	--	1.8'/4'	--	GRAVEL: boulder to 75.5', then c gravel, various lithologies
80	14 45 75 110	0	9"	38	GRAVEL: olive gray (5Y 3/2) angular gravel, some c-m sand, little silt, moist to wet
82	74 100/0.4' rollerbit to 83'	0	11"	39	SAND & SILT: vc to m sand, trace gravel, trace silt, wet, then olive gray silt, trace gravel, trace f-sand, dense, wet to saturated
84	Drove Casing to 83' 100/0.4' rollerbit	0	0	40	DOLOSTONE: medium gray (N4), competent, layered, high angle fractures
86 88	HX Core	--	3.2'/5'	R1	
90 92 94	HX Core	--	5'/5'	R2	





WELL CONSTRUCTION DETAILS

#00 grade sand pack (66' - 83.5')

2" dia. 10-Slot PVC screen (68' - 83')

5" dia .mud rotary borehole (46'- 83')

4" Dia. borehole (84.5 '- 94.5')

Bentonite chips (83.5' to 94.5')

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GROUNDWATER SCIENCES CORPORATION

GEOLOGIC LOG: SRMW-13R

PROJECT INFORMATION

PROJECT: ***Shenandoah Road RI***
SITE LOCATION: ***Town of East Fishkill, Dutchess Co., NY***
JOB NO.: ***01003.11.0105***
LOGGED BY: ***B. Titone/E. Stoner***
DATES DRILLED: ***8/1/06 -8/16/06***

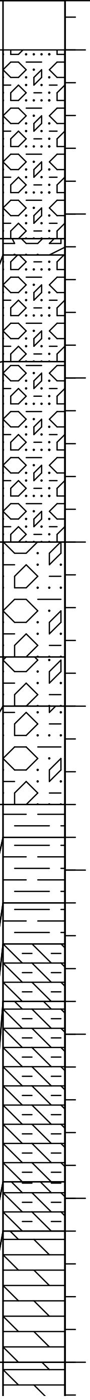
DRILLING INFORMATION

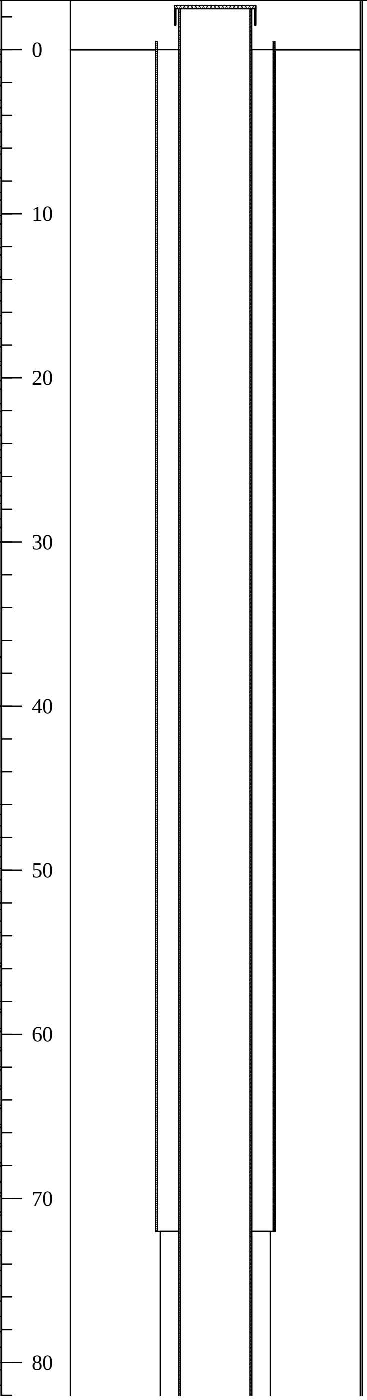
DRILLING CO.: ***Eichelbergers Inc.***
DRILLER: ***C. Knaub***
RIG TYPE: ***IR T4W***
DRILLING METHOD: ***Air Rotary***
DEVELOPMENT DATE: ***8/16/06***
LOCATION: ***End of Old Shenandoah Rd., adjacent to I-84***

NOTES: SWL = 30.00' below TOC, 8/17/06
TOC elevation: 333.35 ft amsl
Cummulative blown yield <15 gpm

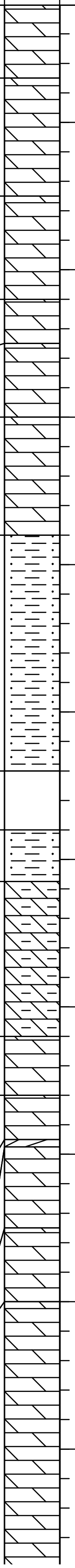
SURFACE ELEVATION: 330.11 ft amsl
NORTHING: 983969.01 EASTING: 685517.71

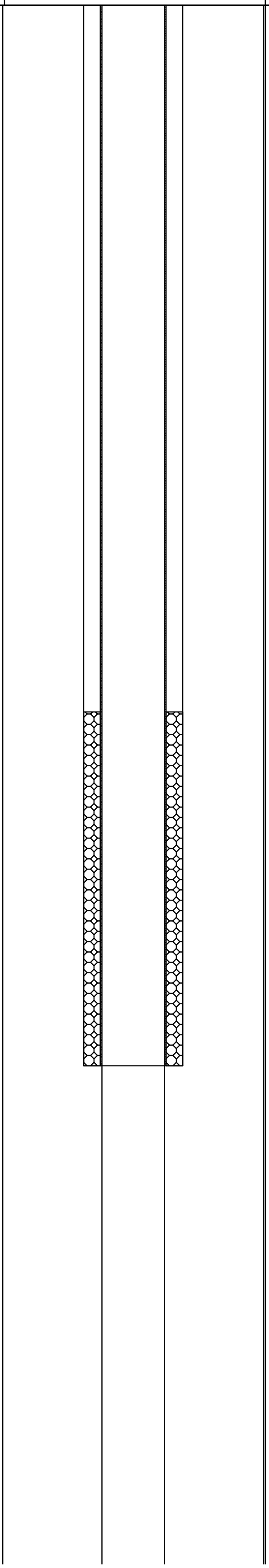
DEPTH FEET	CUM. BLOWN YIELD	VOC (ppm)	LITHOLOGY	WELL CONSTRUCTION DETAILS
0 10			SILT, SAND & GRAVEL: dk yellowish brown (10 YR 4/2) vc sand, silt and gravel, some vc A-SR gravel, cohesive, moist	6" locking well cap
			COBBLES: broken rock or gravel, possible cobbles or boulder	
			SILT, SAND & GRAVEL: light olive gray (5 Y 5/2) silt w/ vc sand and fine SA-SR gravel, various lithologies, some c gravel zones, cohesive, moist	
20			SILT, SAND & GRAVEL: light olive gray vc sand, tr c sand, vc-vf SA-SR gravel w/ granules, various lithologies, cohesive, damp	10" dia. steel casing with STRADEX driveshoe, 0' to 72'
30			SILT W/ GRAVEL: light olive gray, pred. gravel/granules, vf-vc, A-SA, occ SR, tr vc sand, various lithologies	
40			SILT W/ GRAVEL: light olive gray, more silt than above, A-SA gravel, occ SR, c-vf gravel, w/ granules, tr c-vc sand, various lithologies	6" dia.steel casing with driveshoe, +2.5' to 154'
			SILT W/ GRAVEL: moderate yellowish brown (10 YR 5/4) mostly silt, w/ SA-SR gravel, tr c-vc sand, various lithologies	
50			SHALE: grayish black (N2), weathered, med dk gray (N4) to lt olive gray (5 Y 6/1) vein qtz and mod yellowish brown (10 YR 5/4) silt masses, iron-stained fracture surfaces	
			SHALE: grayish black, w/ interbedded mod yellowish brown silty sandstone, laminated, occ SR sandstone clasts, , w/ vein qtz, iron-stained fracture skin, tr. lt gray qtzite, tr silt masses	
60	0.5 gpm	0	SHALE: as above, no silt masses, tr garnet?, thin olive gray (5 Y 4/1) laminations, plumose structure on fractures	
			SHALY DOLOSTONE: grayish black w/pale yellowish brown (10 YR 6/2) lams, v. dark red (5 R 2/6) patches, w/ grayish black (N2) to lt olive brown (5 Y 5/6) dolostone, some mod. yell. brown lams, common vein qtz, iron-stained fractures	
70	0.1 gpm	0	SHALY DOLOSTONE: grayish black to med, dk gray, occ. quartz vein, occ. shaly layers, elongated pyrite, pred. dark gray (N3) dolostone 67'-69', shaly, tr. pyrite	10" dia. steel casing with STRADEX driveshoe, 0' to 72'
			SHALY DOLOSTONE: dark gray with shaly layers, pyritic, some iron-staining and healed fractures	
			DOLOSTONE: dark gray, hard, shaly layers, thin pyrite laminations on sedimentary surfaces	
80			DOLOSTONE: med dk gray to med gray (N5), hard,	

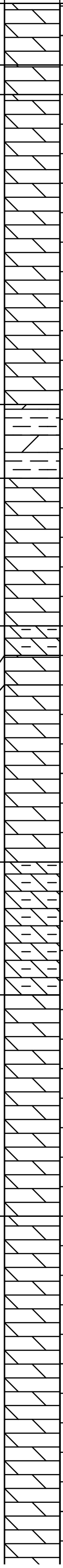




DEPTH FEET	BLOWN YIELD (GPM)	VOC (ppm)	LITHOLOGY	WELL CONSTRUCTION DETAILS
			with dark gray dolomitic shale zones, pyrite common	
90			DOLOSTONE: med dk gray, hard, with pyrite traces, healed fractures w/ quartz veining, small fracture at 90 ft	9.5" dia. air rotary borehole, 72' to 154'
100	>30 gpm	0	DOLOSTONE: grayish black, hard, vein quartz present, healed fractures, brecciated dolostone in qtz	
			DOLOSTONE: grayish black, hard, sl shaly, prominent pyrite	
			DOLOSTONE: dark gray, tr pyrite, hard, sl shaly zones, tr qtz veining	
110			DOLOSTONE: grayish black, hard, tr pyrite, fractures at 110 ft and 115 ft, water-bearing at 115 ft, some yellow brown mud	
120 130			MUD VOID: large pieces of grayish black dolostone with mod. yellow brown mud, w/ pocket qtz, water-bearing, little return, milky qtz crystals and masses, some shale frags, and mod yellowish brown limonite nodules	6" dia.steel casing with driveshoe, +2.5' to 154'
			LOST CIRCULATION: drilled like rock, no recovery	
140			MUD VOID: soft zone	
150			SHALY DOLOSTONE: dark gray to lt olive gray, occasional qtz zones	Bentonite chip 6x9.5 annular seal, 130' to 154'
	35 gpm	0	DOLOSTONE: grayish black, competent	
160			DOLOSTONE: grayish black w/ small layers of med dk gray, small pieces of dk shale w/ dk yellowish brown (10 YR 4/2) sandy dolostone	
			WEATHERED DOLOSTONE: grayish black, broken, fracture skin, and slicken surfaces, and dk yellowish brown sandy dolostone, water-bearing	
			DOLOSTONE: med dk gray competent, tr grayish black dolostone	
170			DOLOSTONE: med dk gray, competent, homogeneous dolostone	
180	15 gpm	0	DOLOSTONE: med dk gray dolostone	6" dia. air rotary borehole, 154'-500'







DEPTH FEET	BLOWN YIELD (GPM)	VOC (ppm)	LITHOLOGY	DEPTH FEET	WELL CONSTRUCTION	WELL CONSTRUCTION DETAILS
190				190		
			DOLOSTONE: as above, some milky qtz, tr graphite			
	15 gpm	0	DOLOSTONE: med dk gray to med gray, hard, competent, qtz layers 202', and 207'-210'			
200				200		
210				210		
			INTERBEDDED DOLOSTONE & SHALE: dolostone and shaly dolostone, grayish black at 215', then interbedded med dk gray dolostone and shaly dolostone			
220	15 gpm	0	DOLOSTONE: layers of dk greenish gray (5 GY 4/1) and med light gray (N6) layers, sl. shaly	220		6" dia. air rotary borehole, 154'-500'
230			SHALY DOLOSTONE: light olive gray shaly dolostone w/ layers of med light gray dolostone	230		
			DOLOSTONE: light olive gray			
			DOLOSTONE: layers of med gray to olive gray (5 Y 4/1), some very fine micaceous texture and sl shaly layers			
240				240		
	15 gpm	0	SHALY DOLOSTONE: med dk gray to med gray and olive gray (5 Y 4/1) layers, some thin lighter bands, sl shaly on break surfaces			
250				250		
			DOLOSTONE: med light gray, occ. thin layered med dk gray, shaly dolostone			
260				260		
270	<15 gpm	0	DOLOSTONE: med gray, some thin layers of olive gray (5 Y 4/1) and med dk gray	270		
280				280		
290				290		

DEPTH FEET	BLOWN YIELD (GPM)	VOC (ppm)	LITHOLOGY	GRAPHIC	DEPTH FEET	WELL CONSTRUCTION	WELL CONSTRUCTION DETAILS
300	<20 gpm	0	DOLOSTONE: tr qtz fracture skin/healed fractures, some infrequent lt gray thin qtz layers		300		
310			DOLOSTONE: medium gray, massive, competent		310		
			DOLOSTONE: medium dark gray, v. slightly shaly, tr small qtz veins				
320	<20 gpm	0	DOLOSTONE: dk gray to med dk gray, some fracture material and mud (qtz and clay)		320		6" dia. air rotary borehole, 154'-500'
			DOLOSTONE: med dk gray to light gray (N7), tr milky quartz				
330			DOLOSTONE: same as above		330		
			DOLOSTONE: as above, tr dark gray dolostone and pyrite				
340			DOLOSTONE: med dk gray, some milky qtz, some lighter dolostone layers and tr banding		340		
	18 gpm	0	DOLOSTONE: med dk gray, some olive gray with dark gray banding, tr qtz				
350			DOLOSTONE: med dk gray, tr dark gray banding, fracture qtz/clay material present		350		
			DOLOSTONE: med dark gray, w/ mottled lighter zones, tr milky qtz				
360			DOLOSTONE: as above, tr small dark gray layers		360		
			DOLOSTONE: as above				
370	18 gpm	0	DOLOSTONE: med dk gray, w/ mottled lighter masses		370		
			DOLOSTONE: as above				
380			DOLOSTONE: as above, slightly more dark gray, thinly layered		380		
			DOLOSTONE: as above				
390			DOLOSTONE: dark gray , more platey		390		
	15 gpm	0	DOLOSTONE: grayish black, some lighter mottles zones, pyritic in places, minor milky quartz				

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DEPTH FEET	BLOWN YIELD (GPM)	VOC (ppm)	LITHOLOGY	GRAPHIC	DEPTH FEET	WELL CONSTRUCTION	WELL CONSTRUCTION DETAILS
400			DOLOSTONE: grayish black with thin medium gray layers		400		
			DOLOSTONE: grayish black, brecciated/filled qtz and dolostone				
410			DOLOSTONE: dark gray		410		
	17 gpm	0	DOLOSTONE: grayish black				
420			DOLOSTONE: grayish black w/ filled qtz veins, tr pyrite in qtz veins, occ medium gray layer		420		6" dia. air rotary borehole, 154'-500'
			DOLOSTONE: as above, no pyrite				
430			DOLOSTONE: as above, no pyrite, less vein quartz		430		
	15-18 gpm	0	DOLOSTONE: med dark gray, with some lighter bands, pyrite in thin layers common, little to no vein qtz				
440			DOLOSTONE: med dk gray, mottled to speckled, v. small pyrite specks scattered throughout		440		
			DOLOSTONE: med dk gray, some light/dark masses, pyrite bands/specks common, qtz-filled healed fractures, veins				
450			DOLOSTONE: medium gray, grainy texture, dark/light spots, tr milky vein quartz		450		
	<15 gpm	0	DOLOSTONE: as above, little recovery, more dark spots on quartzite				
460			DOLOSTONE: medium gray		460		
			DOLOSTONE: medium gray				
470			DOLOSTONE: medium dark gray, some lighter zones		470		
	<15 gpm	0	DOLOSTONE: dark gray, trace lighter/darker zones				
480			DOLOSTONE: dark gray		480		
			DOLOSTONE: medium dark gray, some lighter/darker zones				
490			DOLOSTONE: dark gray, tr light/dark zones		490		
	<15 gpm	0	DOLOSTONE: medium gray, some light/dark zones, mottled spotty zones				Total depth: 500 ft
500					500		

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GROUNDWATER SCIENCES CORPORATION

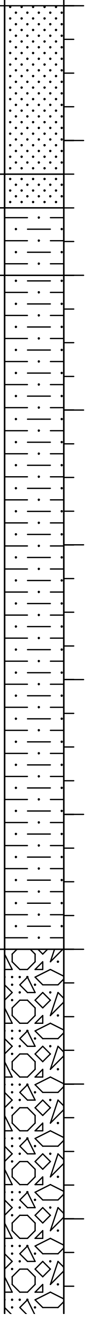
GEOLOGIC LOG: **SRMW-13S**

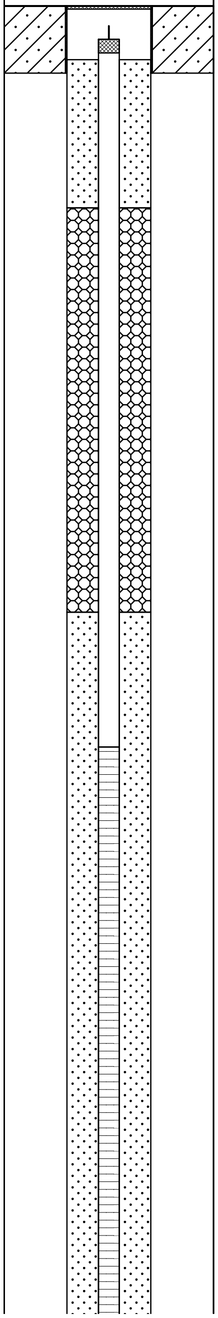
PROJECT INFORMATION		DRILLING INFORMATION	
PROJECT:	***Shenandoah RI***	DRILLING CO.:	***Parratt-Wolff Inc.***
SITE LOCATION:	***Town of East Fishkill, Dutchess Co., NY***	DRILLER:	***Ian Grassie***
JOB NO.:	***01003.11.0105***	RIG TYPE:	***CME 45***
LOGGED BY:	***E. Stoner***	DRILLING METHOD:	***Hollow Stem Auger***
DATES DRILLED:	***10/12/2006 - 10/17/2006***	DEVELOPMENT DATE:	***4/11/07***
		LOCATION:	***End of Old Shenandoah Road, adjacent to SRMW-13***

NOTES: SWL = 12.73' below TOC, 10/26/06, 11:08
TOC elevation: 330.70 ft amsl
Auger refusal at 49 ft (boulder), cored to 50 ft

SURFACE ELEV.	331.05 ft amsl
EASTING	685489.88
NORTHING	983954.81

DEPTH FEET	BLOW COUNTS	VOC (ppm)	RECOV.	SAMP. #	SOIL DESCRIPTION
0	2 9 9 7		23"	1	SAND: medium, little gravel, tr c-vc sand, tr silt, organic rich, moist
2	6 6 6 7		18"	2	SAND: f-vf, well sorted, moist SILT: dark yellowish orange (10YR 6/6), moist
4	7 6 7 7		19"	3	SILT: dark yellowish orange, some SR to R gravel, occasional cobble starting at 6 ft, moist
6	6 5 4 5		16"	4	
8	2 5 8 8		16"	5	
10	5 7 6 17		16"	6	
12	17 33 34 21		4"	7	
14	50/0.4'		2"	8	GRAVEL: with numerous cobbles and boulders
	augered		---	---	
16	augered		---	---	
18	50/0.3'		0"	9	
	augered		---	---	





WELL CONSTRUCTION DETAILS

9" flushmounted manhole w/ 2" cap and lock

8" dia. HSA borehole (0-46.5')

Bentonite chip annular seal (3'-9')

2" dia. sch 40 PVC riser (0.5'-11')

#00 Sand pack (9'-27')

2" dia. 10-slot PVC screen (11'-26')

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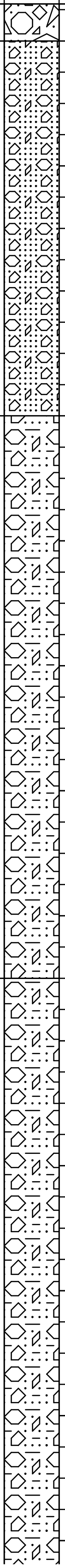
GROUNDWATER SCIENCES CORPORATION

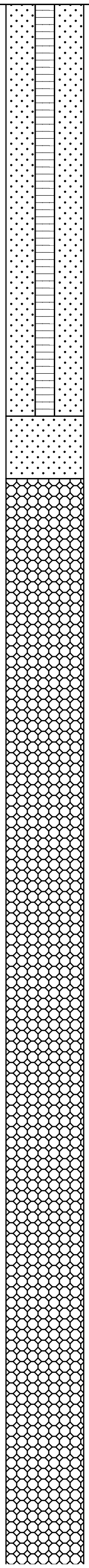
PROJECT: ***Shenandoah RI***

GEOLOGIC LOG: SRMW-13S

DEPTH FEET	BLOW COUNTS	VOC (ppm)	RECOV.	SAMP. #	SOIL DESCRIPTION
20	50/0.2'		0"	10	SAND & GRAVEL: olive gray (5Y 4/1), cobbles present, loose, saturated
	augered		---	---	
22	10 2 50/0.3' augered		0"	11	
24	50/0.4'		2"	12	
	augered		---	---	
26	28 36 50/0.4' augered		12"	13	SILT, SAND & GRAVEL: A-SR gravel, cobbles present, little sand, olive gray, moist, very dense
28	50/0.4'		2"	14	
	augered		---	---	
30	18 50/0.3'		9"	15	
	augered		---	---	
32	50/0.4'		2"	16	
	augered		---	---	
34	30 21 40 30		18"	17	SILT, SAND & GRAVEL: cobbles/boulders of varied lithologies, dark yellowish orange except olive gray from 36 to 38ft and below 46 ft, damp, moisture content decreasing with depth, very dense
36	50/0.3'		4"	18	
	augered		---	---	
38	33 50/0.3'		7"	19	
	augered		---	---	
40	15 30 50/0.4' augered		15"	20	
42	23 50/0.4'		9"	21	
	augered		---	---	
44					



DEPTH FEET: 20, 22, 24, 26, 28, 30, 32, 34, 36, 38, 40, 42, 44



WELL CONSTRUCTION DETAILS

#00 Sand pack (9'-27')

2" dia. 10-slot PVC screen (11'-26')

8" dia. HSA borehole (0-46.5')

Bentonite pellets (27'-50')

Final 9/19/07

GROUNDWATER SCIENCES CORPORATION

PROJECT: ***Shenandoah RI***

GEOLOGIC LOG: SRMW-13S

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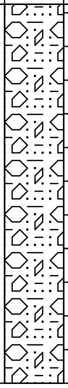
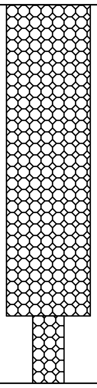
DEPTH FEET	BLOW COUNTS	VOC (ppm)	RECOV.	SAMP. #	SOIL DESCRIPTION	GRAPHIC	DEPTH FEET	WELL CONSTRUCTION	WELL CONSTRUCTION DETAILS
	25 37 50/0.4' augered		16"	22					8" dia. HSA borehole (0-46.5')
46	50/0.4'		4"	23			46		
									Bentonite pellets (27'-50')
48	NX Core		0.9'/3'	RUN 1			48		
									3" HX Core borehole (46.5' - 50')
50							50		

Revised 12/7/07

GROUNDWATER SCIENCES CORPORATION

GEOLOGIC LOG: SRMW-14R

Page 1 of 5

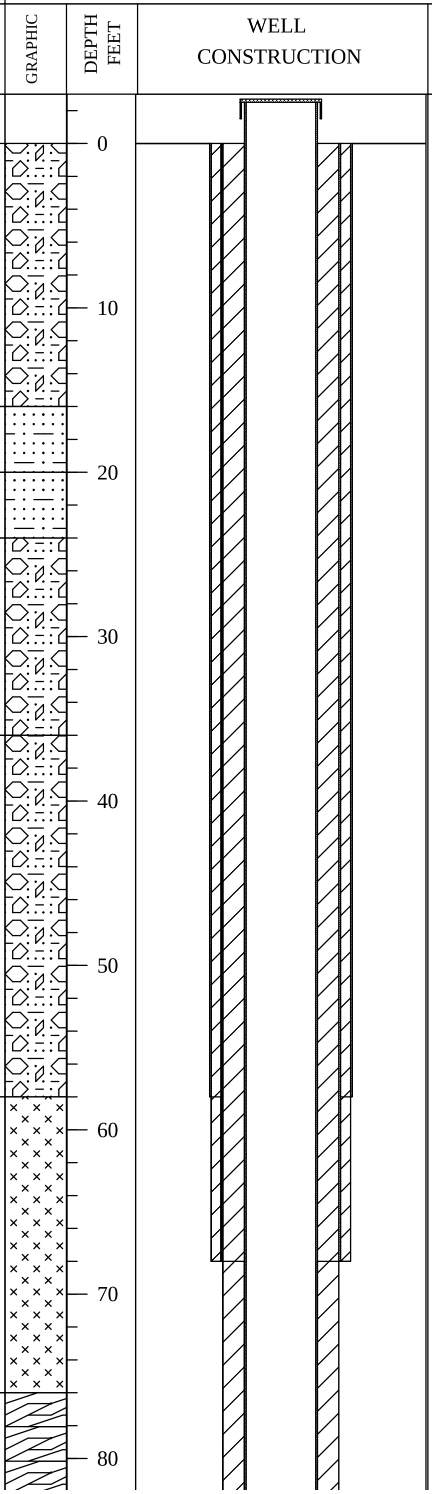
PROJECT INFORMATION		DRILLING INFORMATION	
PROJECT:	***Shenandoah Road RI***	DRILLING CO.:	***Eichelbergers Inc.***
SITE LOCATION:	***Town of East Fishkill, Dutchess Co., NY***	DRILLER:	***C. Knaub***
JOB NO.:	***01003.11.0105***	RIG TYPE:	***IR T4W***
LOGGED BY:	***B. Titone/S. Fisher***	DRILLING METHOD:	***Air Rotary***
		DEVELOPMENT DATE:	***10/17/06***
DATES DRILLED:	***10/5/06 - 10/17/06***	LOCATION:	***E. side of Shenandoah Rd., immediately S. of Jackson Rd.***

NOTES: SWL = 58.08' below TOC, 10/18/06, 10:00
TOC elevation: 351.37 ft amsl
FLUTE system installed October 2007

SURFACE ELEVATION: 348.97 ft amsl

NORTHING: 983407.83 EASTING: 685725.39

DEPTH FEET	CUM. BLOWN YIELD	VOC (ppm)	LITHOLOGY
0			SILT, SAND & GRAVEL: med. brown, SA-SR f-m grained
10			
			SAND & SILT: orange brown. f-m sand
20			SAND & SILT: orange brown vf-m sand, tr. fine-grained
			SILT, SAND & GRAVEL: orange brown. some vc gravel layers of various lithologies, firm
30			
			SILT, SAND & GRAVEL: olive gray, mostly granules to m-grained, A-SA gravel of various lithologies, more competent
40			
50			
			QUARTZITE: moderate yellowish brown, sl. weathered, sandy/sugary texture, iron staining, some minor fractures
60			
70			
			FRACTURED QUARTZITE: moderate yellowish brown, iron staining, abundant milky quartz and crystalline quartz, some orange brown clay, some mylonitic texture
80			



WELL CONSTRUCTION DETAILS

6" locking well cap

12" dia. steel casing, 0' to 58'

Bentonite slurry 10"x12" annular seal, 0 to 68'

10" dia. steel casing with STRADEX driveshoe, 0' to 68'

Bentonite slurry 10"x6" annular seal, 0' to 68'

6" dia.steel casing with driveshoe, +2.5' to 145'

12" dia. air rotary borehole, 58' to 68'

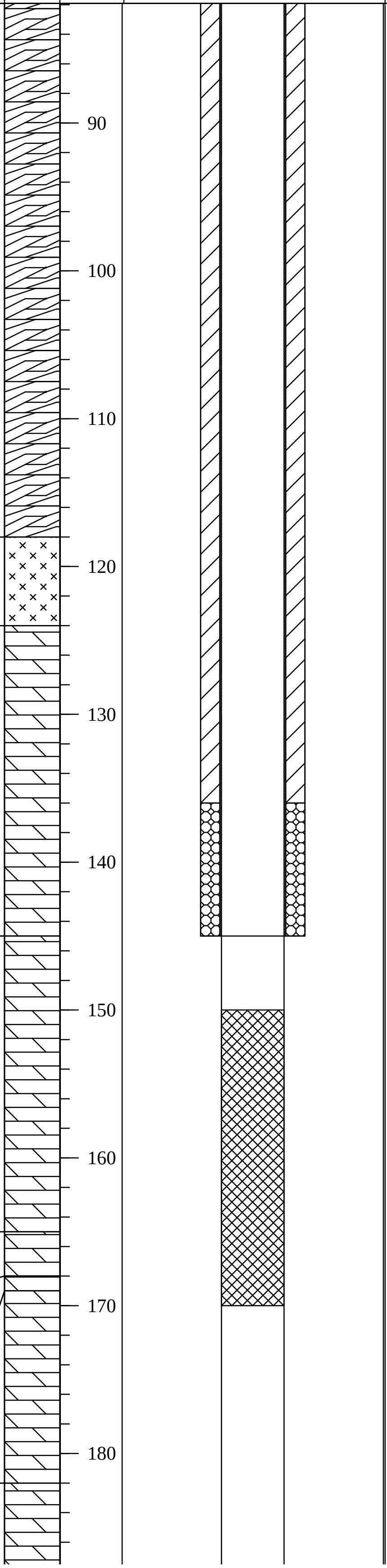
9.25" dia. air rotary borehole, 68' to 145'

Revised 12/7/07

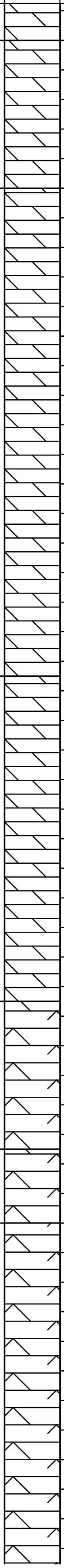
GROUNDWATER SCIENCES CORPORATION

***GEOLOGIC LOG:* SRMW-14R**

DEPTH FEET	BLOWN YIELD (GPM)	VOC (ppm)	LITHOLOGY	WELL CONSTRUCTION DETAILS
90				
100				Bentonite slurry 9.25"x6" annular seal, 68' to 136'
110				
120			QUARTZITE: moderate yellowish brown, sl. weathered, sandy/sugary texture, iron staining, some minor fractures	6" dia.steel casing with driveshoe, +2.5' to 145'
			DOLOSTONE: moderate light gray, hard	
130				
140				Bentonite chip 6"x9.25" annular seal, 136' to 145'
	0 gpm	0	DOLOSTONE: lt gray (N7) to very lt gray (N8), fine crystalline, slightly quartzose, competent	
150				FLUTe Sample Port # 150 sampling interval 150' - 170'
160				
			DOLOSTONE: medium light gray (N6) fine crystalline, competent	
170	<0.25 gpm	0	DOLOSTONE: medium light gray with trace iron-stained fractures	6" dia. air rotary borehole, 145' to 500'
			DOLOSTONE: meduim light gray, some calcite veining, competent	
180				
			DOLOSTONE: medium gray (N5) softer than above	



Revised 12/7/07



DEPTH FEET	BLOWN YIELD (GPM)	VOC (ppm)	LITHOLOGY	DEPTH FEET	WELL CONSTRUCTION	WELL CONSTRUCTION DETAILS
190			DOLOSTONE: medium light gray, some calcite veining, competent	190		
	<0.25 gpm	0				
200			DOLOSTONE: medium light gray to light gray, finely crystalline, competent	200		
210				210		6" dia. air rotary borehole, 145' to 500'
220	<0.25 gpm	0		220		
230				230		
			DOLOSTONE: dark gray (N3), graphitic, pyritic, softer than above			
240				240		
	<0.25 gpm	0				
250				250		
			CALCAREOUS DOLOSTONE: dark gray, with calcite veining			
260				260		
			CALCAREOUS DOLOSTONE: dark gray, trace of calcite veining, slightly darker in color than above			
270	<0.25 gpm	0	CALCAREOUS DOLOSTONE: dark gray with calcite veining, trace of pyrite	270		
280				280		
290				290		

Revised 12/7/07

DEPTH FEET	BLOWN YIELD (GPM)	VOC (ppm)	LITHOLOGY	GRAPHIC	DEPTH FEET	WELL CONSTRUCTION	WELL CONSTRUCTION DETAILS
	<0.25 gpm	0					
300			CALCAREOUS DOLOSTONE: grayish black (N2), graphitic, some white calcite veining		300		
310			DOLOSTONE: medium dark gray (N4) with white vein calcite		310		6" dia. air rotary borehole, 145' to 500'
	0.25 gpm	0					
320					320		
330					330		
	0.25 gpm	0	DOLOSTONE: medium dark gray, trace of pyrite, trace calcite veining, some slickensided surfaces				
340			DOLOSTONE: medium dark gray, no pyrite		340		
			DOLOSTONE: medium dark gray, trace pyrite				
350					350		
	0.5 gpm	0	DOLOSTONE: medium dark gray, pyrite-rich, disseminated and laminated on slickensided surfaces				
360					360		
							FLUTe Sample Port # 364 sampling interval 364' - 384'
			CALCAREOUS DOLOSTONE: dark gray (N3) to grayish black (N2), graphitic, trace of calcite veining				
370					370		
	0.5 gpm	0	CALCAREOUS DOLOSTONE: as above with trace of iron-stained fractures and slickensides				
			CALCAREOUS DOLOSTONE: dark gray, graphitic, trace of calcite veining				
380			DOLOSTONE: medium gray, quartzitic, trace of iron-staining		380		
			DOLOSTONE: medium gray to brownish gray (5 YR 4/1), quartzitic, trace of calcite				
390			QUARTZITE: lt gray (N7) vitreous quartzite, tr dolostone		390		
	0.5 gpm	0	QUARTZITE: medium gray, trace of iron staining, v. lt gray at 395', some small black inclusions, tr dolostone				

Revised 12/7/07

GROUNDWATER SCIENCES CORPORATION

GEOLOGIC LOG: SRMW-14R

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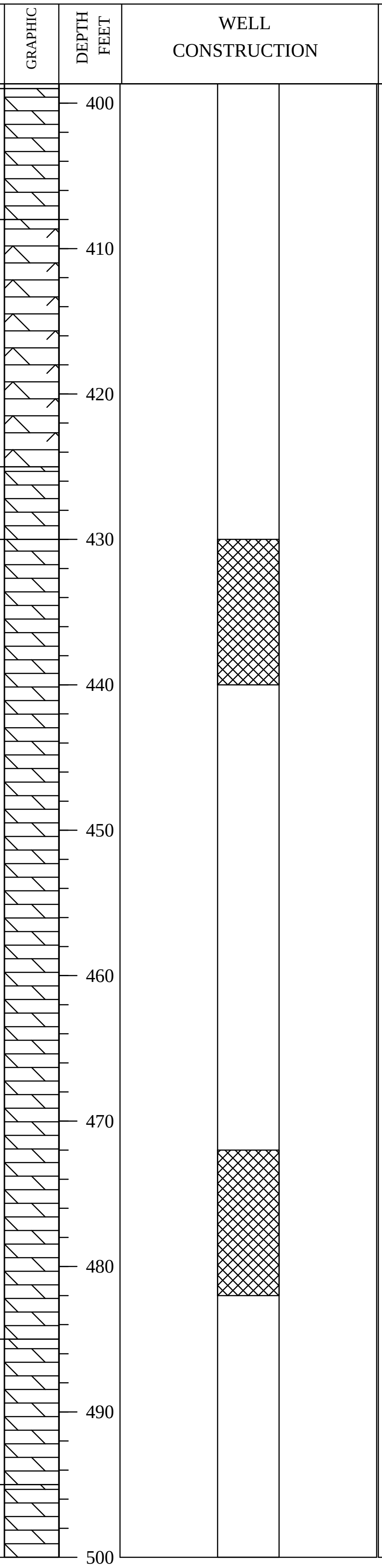
DEPTH FEET	BLOWN YIELD (GPM)	VOC (ppm)	LITHOLOGY	WELL CONSTRUCTION DETAILS
400			DOLOSTONE: medium gray, pyrite-rich	
410			CALCAREOUS DOLOSTONE: dark gray to grayish black, pyrite-rich, graphitic	6" dia. air rotary borehole, 145' to 500'
	0.5 gpm	0		
420				
			DOLOSTONE: medium gray	
430			DOLOSTONE: medium gray with pale olive (10 Y 6/2) shaly interlaminations, trace of pyrite, occasionally quartzose	FLUTe Sample Port # 430 sampling interval 430' - 440'
	0.5 gpm	0		
440				
450				
	1.0 gpm	0		
460				
470				
				FLUTe Sample Port # 472 sampling interval 472' - 482'
	1.0 gpm	0		
480				
			DOLOSTONE: medium gray, interlaminated with brownish gray dolostone	
490				
	1.0 gpm	0		
			DOLOSTONE: medium gray to brownish gray	
500				Total depth: 500 ft



Final 9/19/07

GROUNDWATER SCIENCES CORPORATION

GEOLOGIC LOG: SRMW-14RA/RB

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PROJECT INFORMATION

PROJECT: ***Shenandoah Road RI***
SITE LOCATION: ***Town of East Fishkill, Dutchess Co., NY***
JOB NO.: ***01003.11.105***
LOGGED BY: ***B. Titone***
DATES DRILLED: ***9/14/06 - 9/18/06***

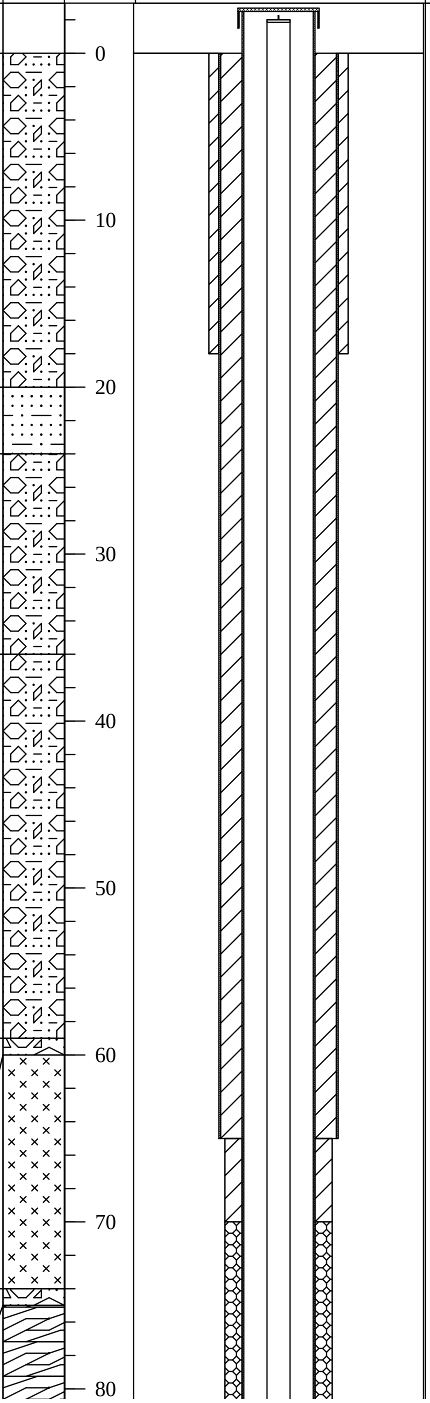
DRILLING INFORMATION

DRILLING CO.: ***Eichelbergers, Inc.***
DRILLER: ***C. Knaub***
RIG TYPE: ***IR T4W***
DRILLING METHOD: ***Air Rotary***
DEVELOPMENT DATE: ***9/18/06***
LOCATION: ***E. side of Shenandoah Rd, immediately S. of Jackson Rd.***

NOTES: SWL = 36.04' below 6" TOC, 9/25/06, 14:15
TOC elevation: 350.81 ft amsl (6"), 350.49 ft amsl (2")
Well reconstructed 6/07: 14RA - 2" PVC, 14RB - 6x2" annulus

SURFACE ELEVATION: 348.18 ft amsl
NORTHING: 983417.73 EASTING: 685726.60

DEPTH FEET	CUM. BLOWN YIELD	VOC (ppm)	LITHOLOGY
0			SILT, SAND & GRAVEL
20			SAND & SILT: as above, vf-m sand, tr. f-grained
			SILT, SAND & GRAVEL: orange brown, some v-c gravel layers of various lithologies, firm
40	1-2 gpm	0	SILT, SAND & GRAVEL: olive gray, mostly granules to m-grained, A-SA, of various lithologies, more competent
60			GRAVEL: med. gray dolostone gravel, m-c some cobbles, SR, with limestone gravel, incl. oolitic limestone
			QUARTZITE: moderate yellowish brown, sl. weathered, sandy/sugary texture, iron staining, some minor fractures
			GRAVEL: med. light gray dolostone gravel with quartzite rock chips
80			FRACTURED QUARTZITE: moderate yellowish brown, heavily fractured, short alternating



WELL CONSTRUCTION DETAILS

6" locking well cap
2" dia sealing well cap
12" dia. air rotary borehole, 0-18'
Bentonite slurry 10"x6" annular seal, 0' to 70'
2" dia. sch 40 PVC riser, +2' to 120'
6" dia. steel casing with drive shoe, +2.5 to 90'
10" dia. steel casing with STRADEX drive shoe, 0 to 65'
9.25" air rotary borehole, 65'-90'
Bentonite chip 9.25"x6" annular seal, 90' to 70'

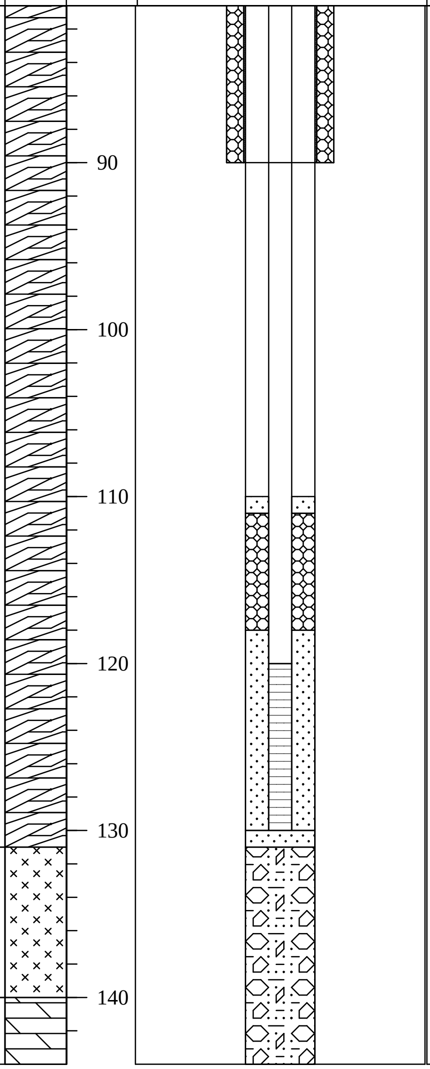
GEOLOGIC LOG: SRMW-14RA/RB

DEPTH FEET	BLOWN YIELD (GPM)	VOC (ppm)	LITHOLOGY
			competent/fractured zones, iron staining, abundant fracture-fill quartz, tr. large pyrite
90			
	Trace	0	
100			
110			
120	5 gpm	0	
130			
			QUARTZITE: moderate yellowish brown, sl. weathered, sandy/sugary texture, iron staining, competent
140			
			DOLOSTONE: light gray to medium gray, competent
	20 gpm	0	

GRAPHIC

DEPTH FEET

WELL CONSTRUCTION



WELL CONSTRUCTION DETAILS

6" dia. steel casing with drive shoe, +2.5 to 90'

2" dia. sch 40 PVC riser, +2' to 120'

6" dia. air rotary borehole, 90' to 140'

Choke sand, 110' to 111'

Bentonite chip 6"x2" annular seal, 111' to 118'

2" dia. 20-slot PVC screen, 120' to 130'

#1 Sand pack, 118' to 131'

Collapsed formation 131' to 144'

Final 9/19/07

GROUNDWATER SCIENCES CORPORATION

GEOLOGIC LOG: SRMW-14S

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PROJECT INFORMATION

PROJECT: *Shenandoah Road RI*
SITE LOCATION: *Town of East Fishkill, Dutchess Co., NY*
JOB NO.: *01003.11.0105*
LOGGED BY: *E. Stoner/B. Titone*
DATES DRILLED: *10/20/06 - 10/24/06*

DRILLING INFORMATION

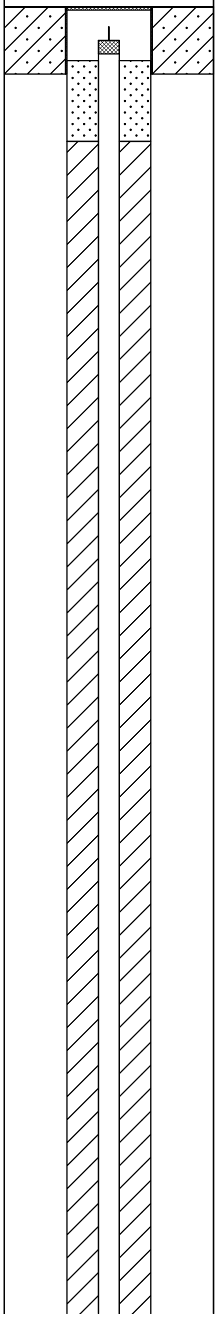
DRILLING CO.: *Parratt Wolff Inc.*
DRILLER: *Ian Grassie*
RIG TYPE: *CME 45*
DRILLING METHOD: *Hollow Stem Auger*
DEVELOPMENT DATE: *3/2/07*
LOCATION: *E. side Shenandoah Rd., immediately S. of Jackson Road*

NOTES: SWL = 31.57 ft below TOC, 10/26/06
Top of casing elevation: 348.66 ft amsl
Used 3" split spoons to 56', then 2" split spoons to 61.7'

SURFACE ELEV. 349.07
EASTING 685720.26
NORTHING 983413.26

DEPTH FEET	BLOW COUNTS	VOC (ppm)	RECOV.	SAMP. #	SOIL DESCRIPTION
0	5 7 10 45	0	21"	1	SILT, SAND & GRAVEL: dark yellowish brown (10 YR 4/2) higher silt content at 1 foot ASPHALT: former road surface
2	36 50/0.4	0	2"	2	SILT, SAND & GRAVEL: medium to coarse sand, silty, w/ SR-R gravel
3	augered	---	---	---	
4	15 9 4 4	0	18"	3	SILT & CLAY: moderte yellowish brown (10 YR 5/4) trace of medium to coarse sand, trace of gravel, moist
6	8 11 13 22	0	19"	4	SAND & GRAVEL: dark yelowish brown, fine to coarse sand, with SR gravel, little silt and clay, trace of caobbles, moist
8	10 15 12 20	---	0"	5	
10	10 21 18 15	0	0"	6	SAND: dark yellowish brown, medium, little fine, trace of coarse to very coarse, occ. silt laminations, loose, moist
12	8 14 17 14	0	16"	7	
14	10 10 14 15	0	18"	8	
16	20 13 18 12	0	17"	9	SAND: dark yellowish brown, fine, moist SAND: dark yellowish orange (10 YR 6/6) very fine, some silt, fine below 18 ft, moist
18	--- --- ---	0	17"	10	SAND & SILT: dark yellowish orange,

WELL CONSTRUCTION



WELL CONSTRUCTION DETAILS

9" Morrison manhole, 2" plug and lock

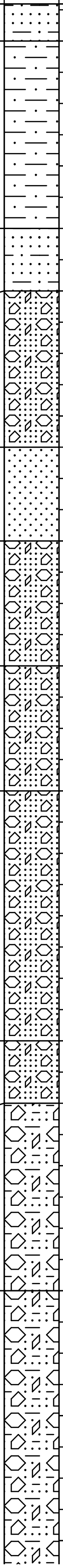
8" dia. HSA borehole (0'-62')

Bentonite slurry annular seal (2'-22')

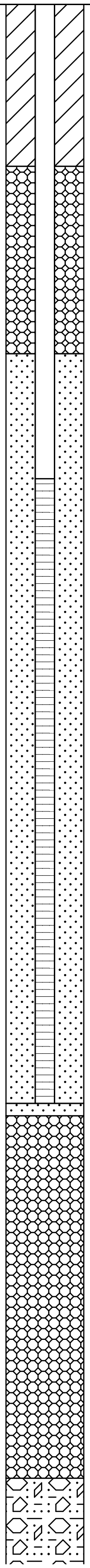
2" dia. sch 40 PVC riser (0.5'-27')

DEPTH FEET	BLOW COUNTS	VOC (ppm)	RECOV.	SAMP. #	SOIL DESCRIPTION
	---				very fine, with some silt, moist
20	8 11 13 14	0	10"	11	SILT: dark yellowish orange, some clay, moist
22	11 8 15 15	0	18"	12	SAND & SILT: dark yellowish orange, four alternating 3-inch layers of vf sand w/ silt lams, and vc sand and f gravel, moist
24	10 17 17 17	0	13'	13	SAND & GRAVEL: dark yellowish brown, fine to very coarse sand and fine gravel, moist
26	19 15 13 14	0	19"	14	SAND: dark yellowish brown, medium to coarse, trace of fine and very coarse, loose, moist
28	19 28 50/0.4' augered	0	9"	15	SAND & GRAVEL: dark yellowish brown, fine to very coarse with fine SR-R gravel, moist
30	50/0.3'	---	0"	16	SAND & GRAVEL: as above with cobbles throughout
	augered	---	---	---	
32	13 19 20 26	0	14"	17	SAND & GRAVEL: coarse to very coarse sand, trace of medium, w/ SR-R gravel, trace of silt, saturated
34	30 28 27 32	0	12"	18	
36	15 36 33 50/0.4'	0	13"	19	SAND & GRAVEL: dark yellowish brown, very fine sand, trace of silt, 1" m sand and gravel layer at 36.5', saturated SILT, SAND & GRAVEL: dark yellowish orange, medium to coarse sand, SA-SR gravel of various lithologies, trace of cobbles, trace of clay, dense, wet
38	11 21 26 28	0	15"	20	
40	8 20 28 32	0	8"	21	SILT, SAND & GRAVEL: light olive gray (5 Y 6/1) to medium gray (N5), moist
42	17 36 50 16	0	9"	22	
44					

GRAPHIC



WELL CONSTRUCTION



WELL CONSTRUCTION DETAILS

Bentonite slurry annular seal (2'-22')

Bentonite chip annular seal (22'-25')

2" dia. sch 40 PVC riser (0.5'-27')

#00 Sand pack (25'-37.2')

2" dia. 10-slot PVC screen (25'-30')

8" dia. HSA borehole (0'-62')

Bentonite pellet backfill (37.2'-43')

Collapsed formation (43'-62')

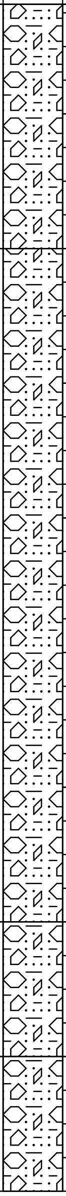
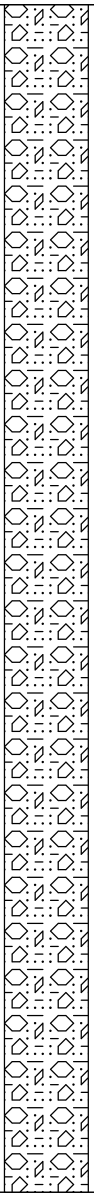
Final 9/19/07

GROUNDWATER SCIENCES CORPORATION

PROJECT: ***Shenandoah Road RI***

GEOLOGIC LOG: SRMW-14S

Page 3 of 3

DEPTH FEET	BLOW COUNTS	VOC (ppm)	RECOV.	SAMP. #	SOIL DESCRIPTION	GRAPHIC	DEPTH FEET	WELL CONSTRUCTION	WELL CONSTRUCTION DETAILS
	36 49 50/0.2' augered	0	9"	23					
46	17 50/0.4'	0	6"	24			46		
	augered	---	---	---					
48	27 50/0.2'	0	5"	25	SILT, SAND & GRAVEL: as above with more cobbles		48		
	augered	---	---	---					
50	50/0.2'	0	1"	26			50		8" dia. HSA borehole (0'-62')
	augered	---	---	---					
52	40 50/0.1'	0	3"	27			52		
	augered	---	---	---					
54	50/0.2'	0	3"	28			54		
	augered	---	---	---					
56	93	---	---	29			56		Collapsed formation (43'-62')
	augered	---	---	---					
58	100/0.7'	---	---	30	SILT, SAND & GRAVEL: olive gray A-SR gravel, medium to coarse sand, moist		58		
	augered	---	---	---					
60	100/0.7'	---	---	31	SILT, SAND & GRAVEL: olive gray f-c A-SR dolostone gravel, w/ f-c sand, silty at bottom w/ tr of gravel and c sand		60		
	augered	---	---	---					
62							62		

Revised 12/7/07

GROUNDWATER SCIENCES CORPORATION

GEOLOGIC LOG: SRMW-15R

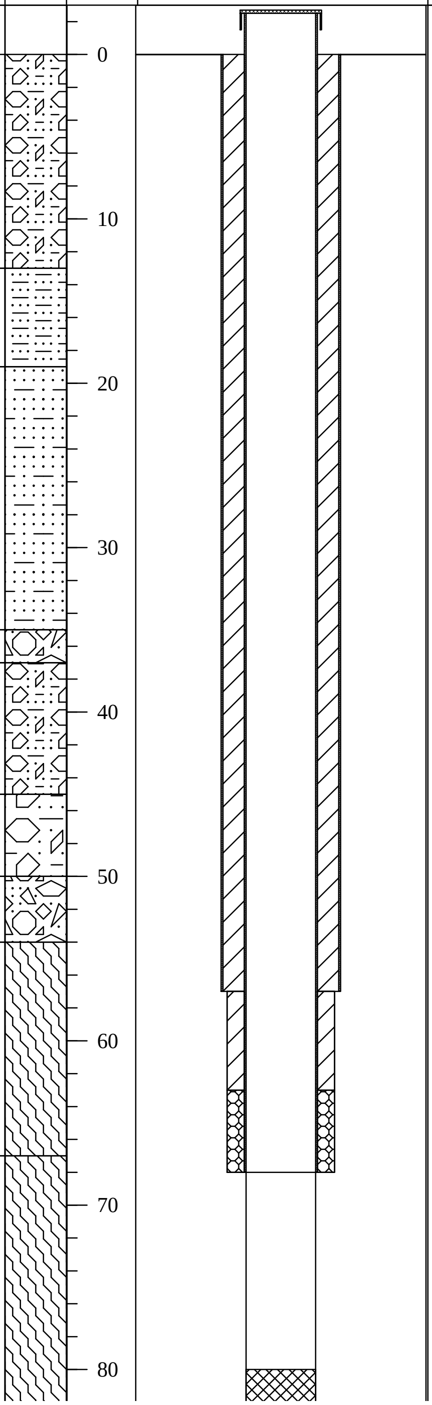
Page 1 of 5

PROJECT INFORMATION		DRILLING INFORMATION	
PROJECT:	*Shenandoah Road RI*	DRILLING CO.:	*Eichelbergers Inc.*
SITE LOCATION:	*Town of East Fishkill, Dutchess Co., NY*	DRILLER:	*C. Knaub*
JOB NO.:	*01003.11.0105*	RIG TYPE:	*IR T4W*
LOGGED BY:	*B. Titone/E. Stoner*	DRILLING METHOD:	*Air Rotary*
DATES DRILLED:	*9/26/06 - 10/2/06*	DEVELOPMENT DATE:	*4/10/07*
		LOCATION:	*S. of Shenandoah cemetery, at E, edge of church parking lot*

NOTES: SWL = 80.45' below TOC, 10/03/06
TOC elevation: 428.19 ft amsl
FLUTe system installed April 2007

SURFACE ELEVATION: 425.58 ft amsl
NORTHING: 982889.28 EASTING: 686542.52

DEPTH FEET	CUM. BLOWN YIELD	VOC (ppm)	LITHOLOGY
0			SILT, SAND & GRAVEL: dark to moderate brown, m-f gravel, SA-SR m-sand occ. cobble, m-c gravel @7', dry
10			SILTY SAND: moderate yellowish brown, m-sand
20			SAND & SILT: dusky yellowish brown, medium sand, well sorted, occ. thin silt layers
30			GRAVEL: m-c gravel, SR-R, some sand and silt
40			SILT, SAND & GRAVEL: dusky yellow brown f-m gravel, some c-gravel, m-f sand, cohesive, moist
			SILT & GRAVEL: grayish orange, granules, various lithologies
50			GRAVEL: c-m, various lithologies
60			GNEISS: yellowish gray to black. biotite prevalent, banded, hard
70			GNEISS: yellowish gray to black, biotite prevalent, banded, tr pyrite/feldspar, hard
80			



WELL CONSTRUCTION DETAILS

6" locking well cap

10" dia. steel casing with STRADEX driveshoe, 0'-57'

Bentonite slurry 10"x6" annular seal, 0-57"

6" dia.steel casing with driveshoe, +2.5' to 37.5'

9.25" dia. air rotary borehole, 57' to 68'

Bentonite slurry 9.25"x6" annular seal, 57' to 63'

Bentonite chip 9.25"x6" annular seal, 63' to 68'

6" dia. air rotary borehole, 68' to 500'

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GROUNDWATER SCIENCES CORPORATION

GEOLOGIC LOG: SRMW-15R

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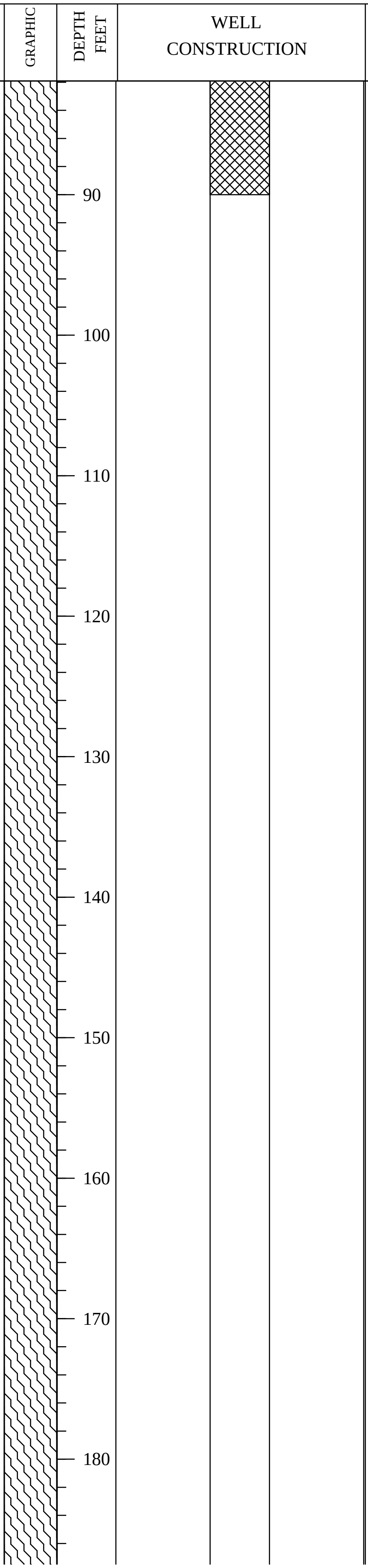
DEPTH FEET	BLOWN YIELD (GPM)	VOC (ppm)	LITHOLOGY	WELL CONSTRUCTION DETAILS
	Trace	0		FLUTe Sample Port # 80 sampling interval 80' - 90'
90				
	0 gpm	0		
100				
110				6" dia. air rotary borehole, 68' to 500'
120	0 gpm	0		
130				
140				
	0 gpm	0		
150				
160				
170	~0.1 gpm	0		
180				



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GROUNDWATER SCIENCES CORPORATION

GEOLOGIC LOG: **SRMW-15R**

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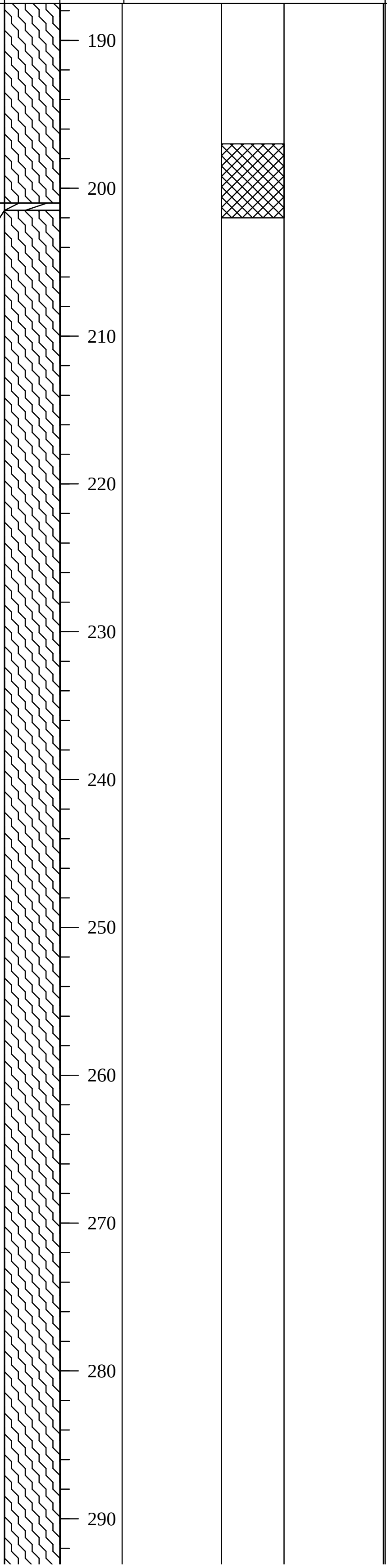
DEPTH FEET	BLOWN YIELD (GPM)	VOC (ppm)	LITHOLOGY	WELL CONSTRUCTION DETAILS
190	~0.1 gpm	0		FLUTe Sample Port # 197 sampling interval 197' - 202'
200	~0.25 gpm	0	FRACTURED GNEISS GNEISS: dark gray to black gneiss, occasional quartz rich zones (bands), occasional pink to orange feldspar, tr. pyrite	
210				
220	~0.25 gpm	0		
230				6" dia. air rotary borehole, 68' to 500'
240	~0.25 gpm	0		
250				
260				
270	~0.25 gpm	0		
280				
290				



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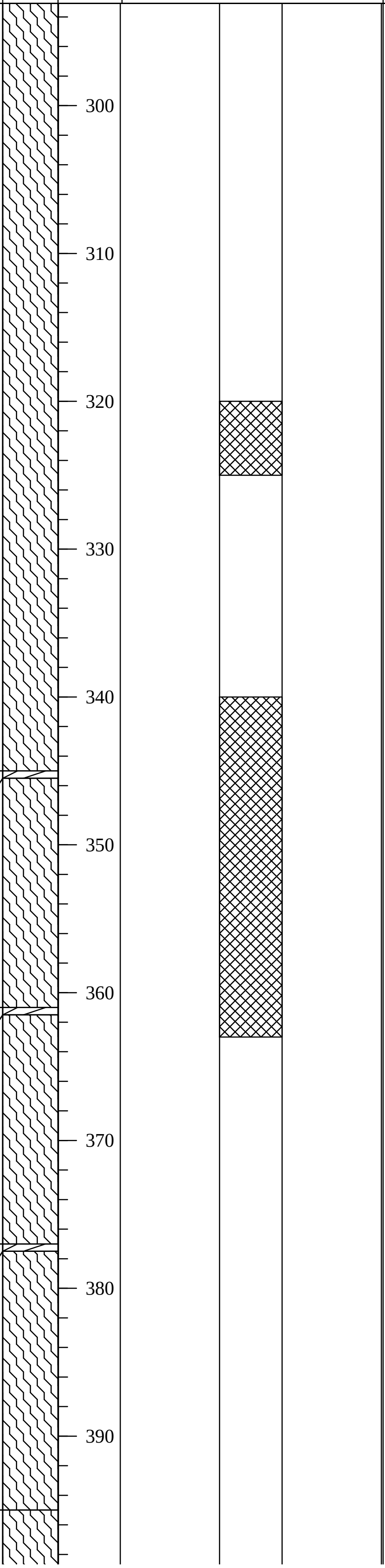

DEPTH FEET	BLOWN YIELD (GPM)	VOC (ppm)	LITHOLOGY	WELL CONSTRUCTION DETAILS
	~0.25 gpm	0		
300				6" dia. air rotary borehole, 68' to 500'
310				
320	~0.25 gpm	0		FLUTe Sample Port # 320 sampling interval 320' - 325'
330				
340				FLUTe Sample Port # 340 sampling interval 340' - 363'
	10 gpm	0	FRACTURED GNEISS GNEISS: dark gray to black gneiss, occasional quartz rich zones (bands), occasional pink to orange feldspar, tr. pyrite	
350				
360			FRACTURED GNEISS GNEISS: dark gray to black gneiss, occasional quartz rich zones (bands), occasional pink to orange feldspar, tr. pyrite	
370	12 gpm	0		
			FRACTURED GNEISS GNEISS: dark gray to black gneiss, occasional quartz rich zones (bands), occasional pink to orange feldspar, tr. pyrite	
380				
390				
	15-20 gpm	0	GNEISS: dark gray to black gneiss, occasional quartz rich zones (bands), occasional pink to orange feldspar,	

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GROUNDWATER SCIENCES CORPORATION

GEOLOGIC LOG: SRMW-15R

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DEPTH FEET	BLOWN YIELD (GPM)	VOC (ppm)	LITHOLOGY	GRAPHIC	DEPTH FEET	WELL CONSTRUCTION	WELL CONSTRUCTION DETAILS
400					400		
410					410		6" dia. air rotary borehole, 68' to 500'
	15-20 gpm	0					
420					420		
430					430		
	15-20 gpm	0					
440					440		
450					450		
	15-20 gpm	0					
460					460		
470					470		
	15-20 gpm	0					
480					480		
490					490		
	15-20 gpm	0					Total depth: 500 ft
500					500		

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GROUNDWATER SCIENCES CORPORATION

GEOLOGIC LOG: SRMW-15S

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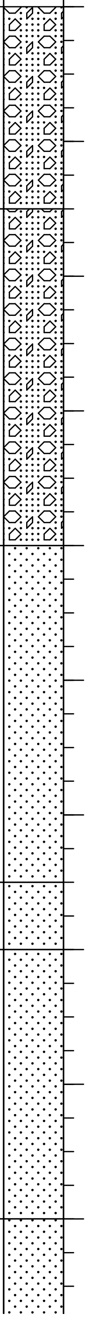
PROJECT INFORMATION		DRILLING INFORMATION	
PROJECT:	*Shenandoah RI*	DRILLING CO.:	*Parratt-Wolff Inc.*
SITE LOCATION:	*Town of East Fishkill, Dutchess Co., NY*	DRILLER:	*Ian Grassie*
JOB NO.:	*01003.11.0105*	RIG TYPE:	*CME 45*
LOGGED BY:	*E. Stoner*	DRILLING METHOD:	*Hollow Stem Auger*
DATES DRILLED:	*10/18/2006 - 10/20/2006*	DEVELOPMENT DATE:	*3/26/07*
		LOCATION:	*E. end of church parking lot, next to SRMW-15R*

NOTES: SWL = 54.65' below TOC, 10/26/06, 8:47
Top of casing elevation: 424.59 ft amsl
Well screen set 4 ft into bedrock

SURFACE ELEV.	425.09
EASTING	686551.56
NORTHING	982885.45

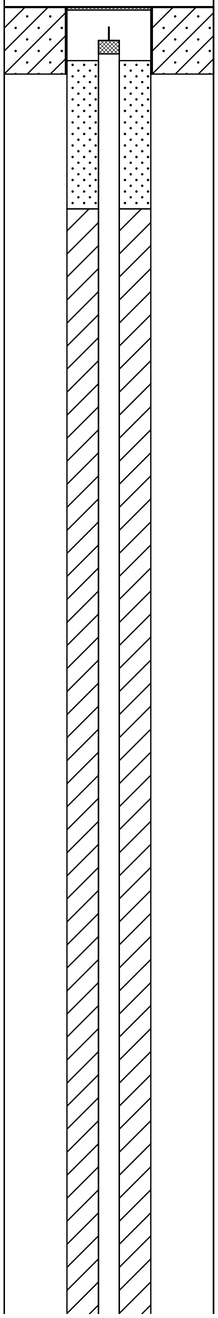
DEPTH FEET	BLOW COUNTS	VOC (ppm)	RECOV.	SAMP. #	SOIL DESCRIPTION
0	3 7 7 5	0	12"	1	SAND & GRAVEL: trace of silt, moist
2	4 4 3 4	0	8"	2	SAND & GRAVEL: moderate brown (5 YR 4/4) m-f, tr c, and R to SR gravel, some silt, moist
4	4 6 5 15	0	13"	3	
6	16 24 17 15	0	2"	4	
8	10 9 7 7	0	13"	5	SAND: moderate brown, m-c, tr f, tr R to SR gravel, tr silt, damp
10	12 12 12 8	0	11"	6	
12	12 11 9 9	0	23"	7	SAND: m-c, tr vf gravel
14	5 7 7 7	0	15"	8	SAND: dark yellowish brown (10 YR 4/2) medium, grading to fine sand, several sequences seperated by silt laminations, loose, moist, occasional gravel; 1 inch vc sand/vf gravel layers at 16.5 and 18 ft; 2 inch clay layer at 17.5 ft
16	11 14 11 15	0	20"	9	
18	15 15 14	0	19"	10	SAND: dark yellowish brown, m-f, several c-vc layers of about 1 inch, varied lithologies

GRAPHIC



DEPTH FEET: 0, 2, 4, 6, 8, 10, 12, 14, 16, 18

WELL CONSTRUCTION



WELL CONSTRUCTION DETAILS

9" Morrison manhole, 2" plug and lock

8" dia. HSA borehole (0'-54')

Bentonite slurry annular seal (3'-43')

2" dia. sch 40 PVC riser (0.5'-48')

GROUNDWATER SCIENCES CORPORATION

GEOLOGIC LOG: SRMW-15S

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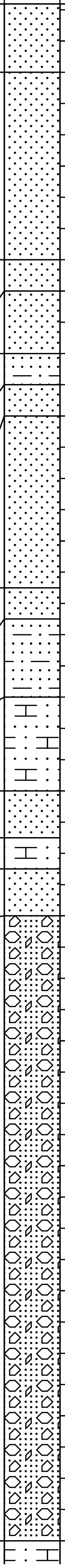
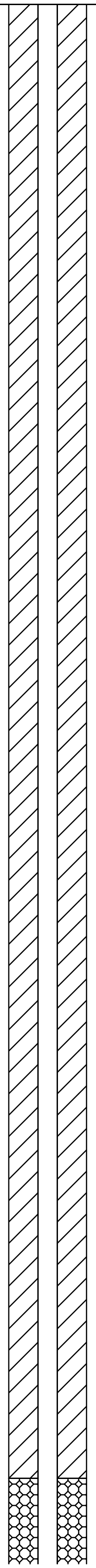
PROJECT: ***Shenandoah RI***

DEPTH FEET	BLOW COUNTS	VOC (ppm)	RECOV.	SAMP. #	SOIL DESCRIPTION
	11				
20	6 10 11 10	0	18"	11	SAND: moderate yellowish brown, vf-f, four 1/8 to 1 inch m sand layers grading to vf sand from 21 to 22 ft, moist
22	9 9 12 16	0	14"	12	SAND: dark yellowish brown, m-c, loose, moist
24	6 8 6 9	0	22"	13	SAND: dark yellowish brown, m-f, moist SAND & SILT: m-f alternating with silt and clay units of less than 0.5 inches
26	10 11 14 18	0	21"	14	SAND: dark yellowish brown, m-c, silt laminations, loose, moist SAND: dark yellowish brown, f-vf, slightly coarser near 28 ft, moist
28	12 23 15 16	0	24"	15	SAND: dark yellowish brown, f-vc, tr vf gravel, loose, moist SAND & SILT: dark yellowish orange (10 YR 6/6), vf sand, some clay laminations, tr vc and fine gravel, wet
30	18 10 10 12	0	22"	16	CLAY & SILT: dark yellowish orange, <1/8 inch vf sand layer at 31.5 ft
32	9 10 25 50/0.4'	0	19"	17	SAND: dark yellowish brown, vf, moist CLAY & SILT: dark yellowish orange SAND: dark yellowish brown, c-vc , vf, f, vf in 2 inch layers
34	22 50/0.4'	0	6"	18	SAND & GRAVEL: medium light gray (N7) m-c, silty, w/ gravel, possible cobbles, loose, damp, driller reports difficult augering
	augered	---	---	---	
36	50/0.4'	0	3"	19	
	augered	---	---	---	
38	50/0.3'	0	3"	20	
	augered	---	---	---	
40	50/0.4'	0	2"	21	
	augered	---	---	---	
42	50/0.4'	0	1"	22	
	augered	---	---	---	
44					

GRAPHIC



WELL CONSTRUCTION



WELL CONSTRUCTION DETAILS

8" dia. HSA borehole (0'-54')

Bentonite slurry annular seal (3'-43')

2" dia. sch 40 PVC riser (0.5'-48')

Bentonite chip annular seal (43'-46')

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GROUNDWATER SCIENCES CORPORATION

GEOLOGIC LOG: SRMW-15S

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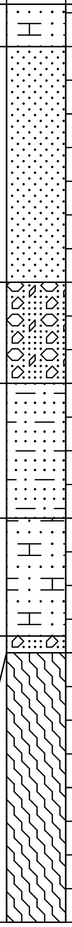
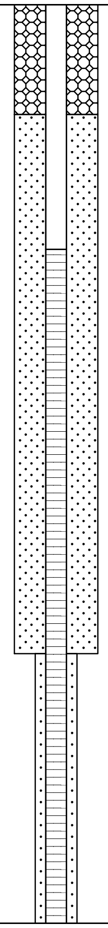
PROJECT: ***Shenandoah RI***

DEPTH FEET	BLOW COUNTS	VOC (ppm)	RECOV.	SAMP. #	SOIL DESCRIPTION
45–46	11 24 26 40	0	20"	23	CLAY & SILT: moderate yellowish brown, SAND: moderate yellowish brown, vf-f sand, occasional silt/clay zones, moist
46–48	32 34 43 46	0	23"	24	
48–49	24 50/0.2'	0	5"	25	SAND & GRAVEL: possible silt and cobble zone
49–50	augered	---	---	---	
50–52	10 9 5 10	0	21"	26	SAND & SILT: moderate yellowish brown, vf, and silt, tr gravel, wet
52–54	22 12 19 50	0	13"	27	CLAY & SILT: dusky yellow (5Y 6/4) SAND & GRAVEL: dusky yellowish brown (10 YR 2/2) c-vc, and gravel, tr silt, wet
54	50/0'	---	---	---	
54.5–58	HQ Core	---	3.9'/ 4.0'	RUN 1	GNEISS: biotite quartz gneiss, competent





WELL CONSTRUCTION DETAILS

- Bentonite chip annular seal (43'-46')
- 2" dia. sch 40 PVC riser (0.5'-48')
- #00 Sand pack (46'-58')
- 2" dia. 10-slot PVC screen (48'-58')
- HQ Core borehole (54'-58')

Revised 12/7/07

GROUNDWATER SCIENCES CORPORATION

GEOLOGIC LOG: SRMW-16R

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PROJECT INFORMATION

PROJECT: ***Shenandoah Road RI***
SITE LOCATION: ***Town of East Fishkill, Dutchess Co., NY***
JOB NO.: ***01003.11.0105***
LOGGED BY: ***B. Titone/E. Stoner***
DATES DRILLED: ***8/29/06 - 8/31/06***

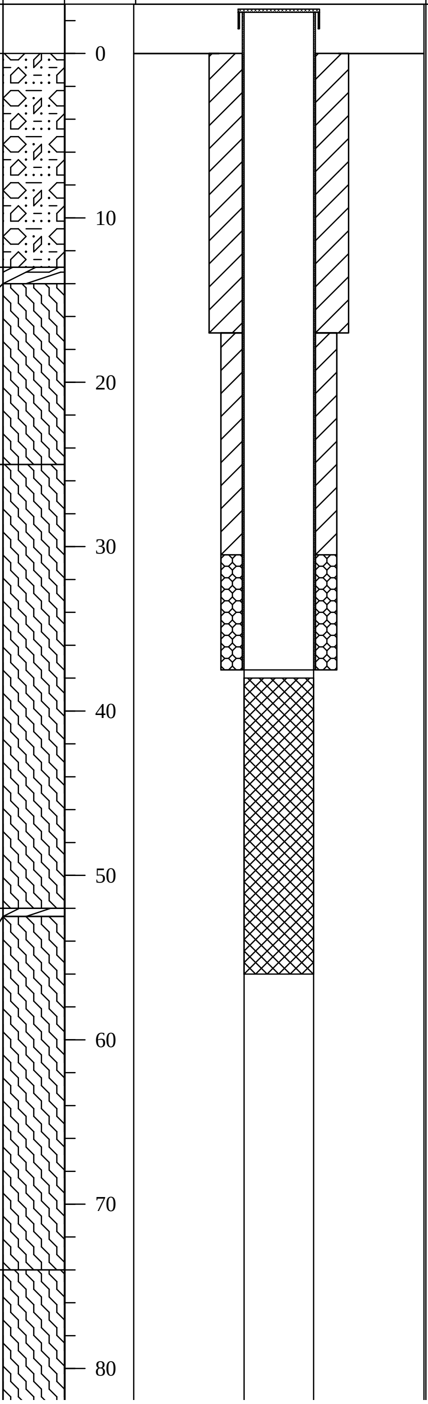
DRILLING INFORMATION

DRILLING CO.: ***Eichelbergers Inc.***
DRILLER: ***C. Knaub***
RIG TYPE: ***IR T4W***
DRILLING METHOD: ***Air Rotary***
DEVELOPMENT DATE: ***NA***
LOCATION: ***W. side of Shenandoah Rd., in church school yard***

NOTES: SWL = 40.0' below TOC, 9/1/06
TOC elevation: 420.76 ft amsl
FLUTe system installed July 2007

SURFACE ELEVATION: 417.75 ft amsl
NORTHING: 982773.16 EASTING: 686407.83

DEPTH FEET	CUM. BLOWN YIELD	VOC (ppm)	LITHOLOGY
0			SILT, SAND & GRAVEL: dusky yellow, c-f sand, f-gravel, occ. c gravel, boulder from 5'-7', loose, dry
10			WEATHERED GNEISS
			GNEISS: light gray, biotite and quartz dominant, occ. pink feldspar, fine grained
20			
			GNEISS: granitic gneiss with biotite, hornblende, and smoky quartz
30			
40			
	0 gpm	0	
50			
			FRACTURED GNEISS
			GNEISS: light gray with black zones/bands/spots, biotite/hornblende present, tr. pink feldspar, pyrite, darker zone @61'-62', very light zone @63'-64'
60			
70	<0.1 gpm	0	
			GNEISS: olive gray to greenish gray, some pink with quartz masses, tr. chalcopyrite from 84'-89', generally fine-grained, some dark zones and quartz-rich zones
80			



WELL CONSTRUCTION DETAILS

6" locking well cap

12" dia. air rotary borehole, 0 to 17'

Bentonite slurry 12"x6" annular seal, 0' to 17'

10" dia. air rotary borehole, 17' to 37.5'

Bentonite slurry 9.25"x6" annular seal, 17' to 30.5'

Bentonite chip 9.25"x6" annular seal, 30.5' to 37.5'

6" dia.steel casing with driveshoe, +2.5' to 37.5'

FLUTe Sampling Port #38 sampling interval 38' - 56'

6" dia. air rotary borehole, 37.5' to 500'

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GROUNDWATER SCIENCES CORPORATION

GEOLOGIC LOG: SRMW-16R

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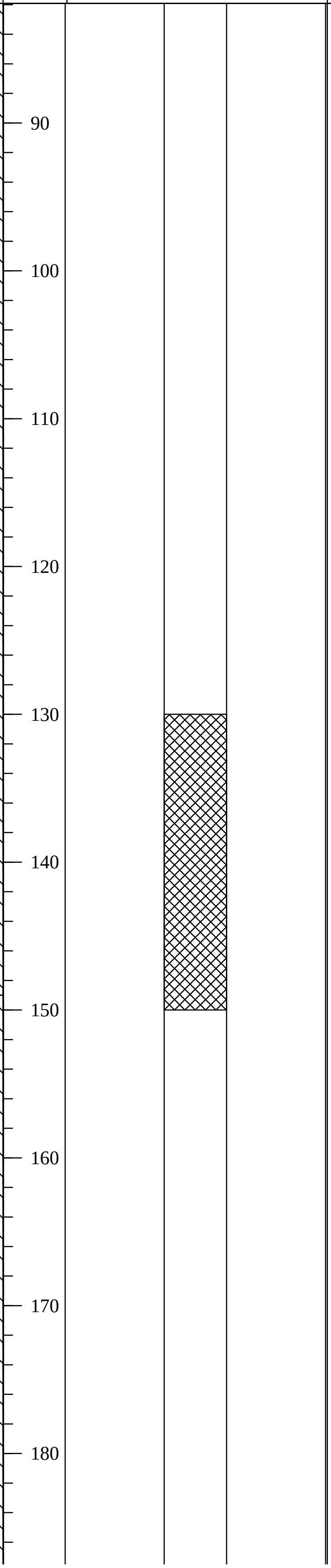
DEPTH FEET	BLOWN YIELD (GPM)	VOC (ppm)	LITHOLOGY	WELL CONSTRUCTION DETAILS
90				
	~0.1 gpm	0		
100				6" dia. air rotary borehole, 37.5' to 500'
110				
120	~0.1 gpm	0		
130				FLUTe Sampling Port #130 sampling interval 130' - 150'
140				
	~1 gpm	0		
150			GNEISS: light gray with darker bands, biotite/quartz/albite/hornblende, tr. pyrite, fine grained, occ. grayish olive, tr. pink feldspar	
160				
170	~1 gpm	0		
180				

WELL CONSTRUCTION



DEPTH FEET	BLOWN YIELD (GPM)	VOC (ppm)	LITHOLOGY	GRAPHIC	DEPTH FEET	WELL CONSTRUCTION	WELL CONSTRUCTION DETAILS
190					190		
	~1 gpm	0	GNEISS: olive gray to greenish black, fine grained. banded, sl. foliated, tr. pyrite, lighter/darker zones, biotite specks, occ. pinkish zone				
200					200		
210					210		6" dia. air rotary borehole, 37.5' to 500'
220	~1 gpm	0			220		
230					230		
240			GNEISS: greenish black with occ. lighter zones, banding, sl. foliation, fine grained, pyrite common, lesser with depth, tr. pink feldspar		240		
	~1 gpm	0					
250					250		
260					260		
270	~1.25 gpm	0			270		
280					280		
290	~1.25 gpm	0			290		

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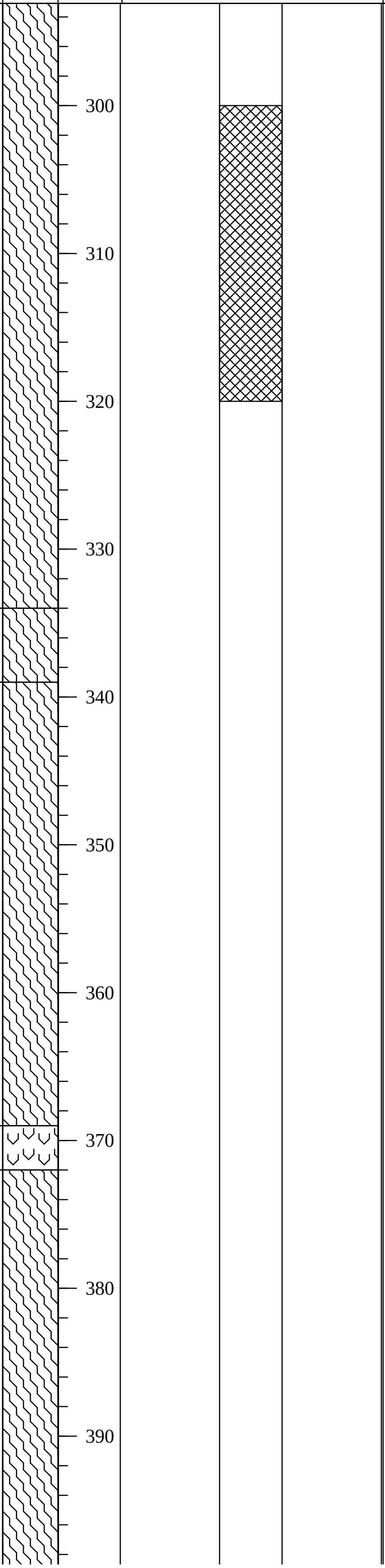
DEPTH FEET	BLOWN YIELD (GPM)	VOC (ppm)	LITHOLOGY	WELL CONSTRUCTION DETAILS
300				FLUTe Sampling Port #300 sampling interval 300' - 320'
310				
320	2 gpm	0		
330				
			GNEISS: pinkish gray and greenish black, mottled, slightly banded/speckled, fine-med. grained	
340			GNEISS: greenish black with dark greenish gray bands, sl. foliated, tr. pyrite, occ. lighter zones	
	3 gpm	0		
350				6" dia. air rotary borehole, 37.5' to 500'
360				
370	3 gpm	0	QUARTZ: quartz and feldspar, coarse grained	
			GNEISS: greenish black, pyrite common, occ. ligher zones, tr. larger biotite	
380				
390				
	3 gpm	0		



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GROUNDWATER SCIENCES CORPORATION

GEOLOGIC LOG: SRMW-16R

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DEPTH FEET	BLOWN YIELD (GPM)	VOC (ppm)	LITHOLOGY	GRAPHIC	DEPTH FEET	WELL CONSTRUCTION	WELL CONSTRUCTION DETAILS
400					400		
410					410		6" dia. air rotary borehole, 37.5' to 500'
	3 gpm	0					
420					420		
430					430		
440			GNEISS: light olive gray with greenish black bands, foliated. biotite rich, tr. pyrite		440		
	3 gpm	0					
450			GNEISS: greenish black, some lighter zones, sl. foliated, tr. pyrite, occ. larger biotite, occ. large grain pink feldspar		450		
460					460		
470					470		
	3 gpm	0					
480					480		
490					490		
	3 gpm	0					
500					500		

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GROUNDWATER SCIENCES CORPORATION

GEOLOGIC LOG: SRMW-17R

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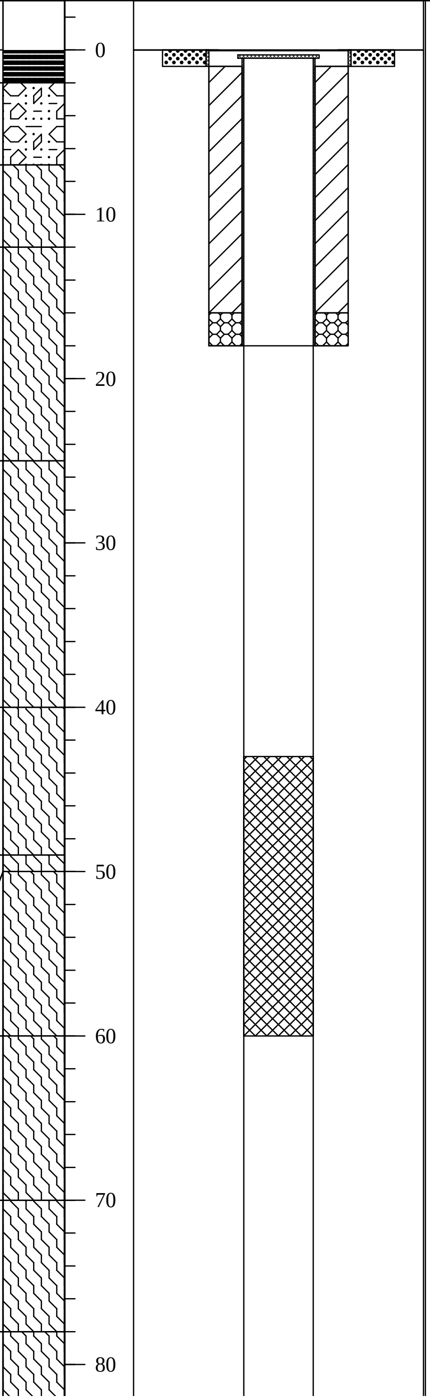
PROJECT INFORMATION		DRILLING INFORMATION	
PROJECT:	*Shenandoah Road RI*	DRILLING CO.:	*Eichelbergers Inc.*
SITE LOCATION:	*Town of East Fishkill, Dutchess Co., NY*	DRILLER:	*C. Knaub*
JOB NO.:	*01003.11.0105*	RIG TYPE:	*IR T4W*
LOGGED BY:	*S. Fisher*	DRILLING METHOD:	*Air Rotary*
		DEVELOPMENT DATE:	*10/24/06*
DATES DRILLED:	*10/19/06 - 10/24/06*	LOCATION:	*North end of Burbank Rd cul-de-sac*

NOTES: SWL = 30.02' below TOC, 10/26/06
Top of casing elevation: 383.44 ft amsl
FLUTe system installed July 2007

SURFACE ELEVATION: 384.01 ft amsl
NORTHING: 982284.77 EASTING: 686567.33

DEPTH FEET	CUM. BLOWN YIELD	VOC (ppm)	LITHOLOGY
0			ASPHALT: asphalt pavement and gravel base to 2 feet
			SILT, SAND & GRAVEL: dark yellowish brown (10 YR 4/2) silt, f-m sand w/ c-vc, and f-m gravel, moist to dry
10			GNEISS: dark greenish gray (5 GY 4/1) quartzose, with biotite, trace of iron-staining, dry
20	0 gpm	0	GNEISS: as above, thin fracture at 12', increasing iron-stained fractures below 15', sl increase of quartz, coarsely crystalline, dry
30			GNEISS: more greenish black (5 G 2/1) to dark gray (N3) less weathered material, some yellow-stained quartz, some felspar, trace of pyrite, decreasing quartz with depth
40	0 gpm	0	GNEISS: predominantly white feldspar and quartz, trace of dark greenish gray gneiss, trace of biotite
50			GNEISS: soft zone at 49', with iron-staining on fractures, about 40% quartz and feldspar
			GNEISS: white feldspar and quartz rich, trace of pink feldspar, micaceous
60			GNEISS: greenish gray, quartz-rich, becoming white feldspar and quartz-rich at 65'
70	0.25 gpm	0	GNEISS: dark greenish gray, some quartz, with abundant iron-staining at 70'
80			GNEISS: predominantly quartz and white feldspar at 80', hard formation



WELL CONSTRUCTION DETAILS

6" locking well cap

12" dia. air rotary borehole, 0 to 18'

Bentonite slurry 12"x6" annular seal, 0' to 16'

6" dia.steel casing with driveshoe, +2.5' to 18'

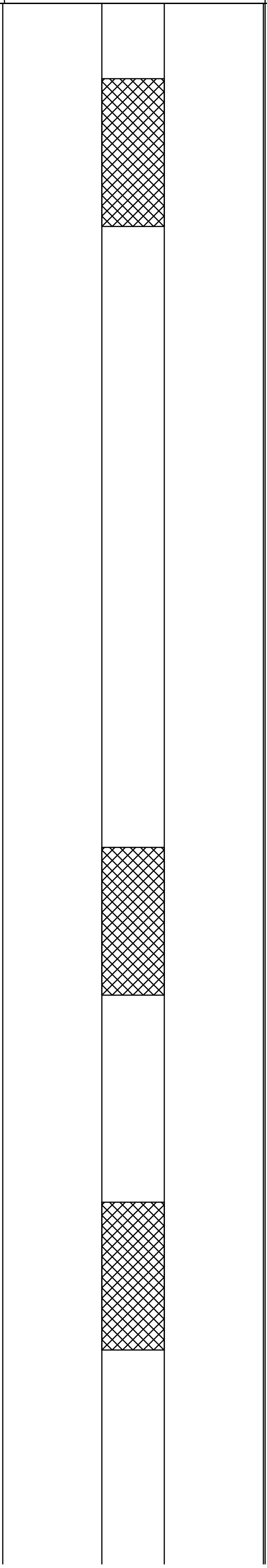
Bentonite chip 12"x6" annular seal, 16' to 18'

6" dia. air rotary borehole, 18' to 500'

FLUTe Sample Port #43 sampling interval 43' - 60'

DEPTH FEET	BLOWN YIELD (GPM)	VOC (ppm)	LITHOLOGY	WELL CONSTRUCTION DETAILS
			GNEISS: dark greenish gray, micaceous, some quartz, quartz and white feldspar-rich at 95'	
				FLUTe Sample Port #87 sampling interval 87' - 97'
90				
	0.25 gpm	0		
100			GNEISS: approximately 50% white feldspar and quartz, some dark greenish gray	
110				6" dia. air rotary borehole, 18' to 500'
120	0.25 gpm	0	GNEISS: dark greenish gray, some quartz and white feldspar, micaceous, trace of pink feldspar	
			GNEISS: predominantly quartz and white feldspar, some greenish gray material	
130				
			GNEISS: dark greenish gray, less quartz and feldspar	
140			GNEISS: abundant white and pink feldspar, harder formation	FLUTe Sample Port #139 sampling interval 139' - 149'
	0.25 gpm	0	GNEISS: predominantly dark gray to greenish gray, some quartz and feldspar, quartz-rich and feldspar-rich at 155'	
150				
160			FRACTURED GNEISS: soft zone, trace of weathered gneiss with iron-staining	
			GNEISS: dark greenish gray, less quartz and feldspar than above	FLUTe Sample Port #163 sampling interval 163' - 173'
170	2 gpm	0	GNEISS: dark greenish gray, some quartz and white feldspar	
180				
			GNEISS: harder formation, increased quartz and white feldspar	

WELL CONSTRUCTION



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GROUNDWATER SCIENCES CORPORATION

GEOLOGIC LOG: **SRMW-17R**
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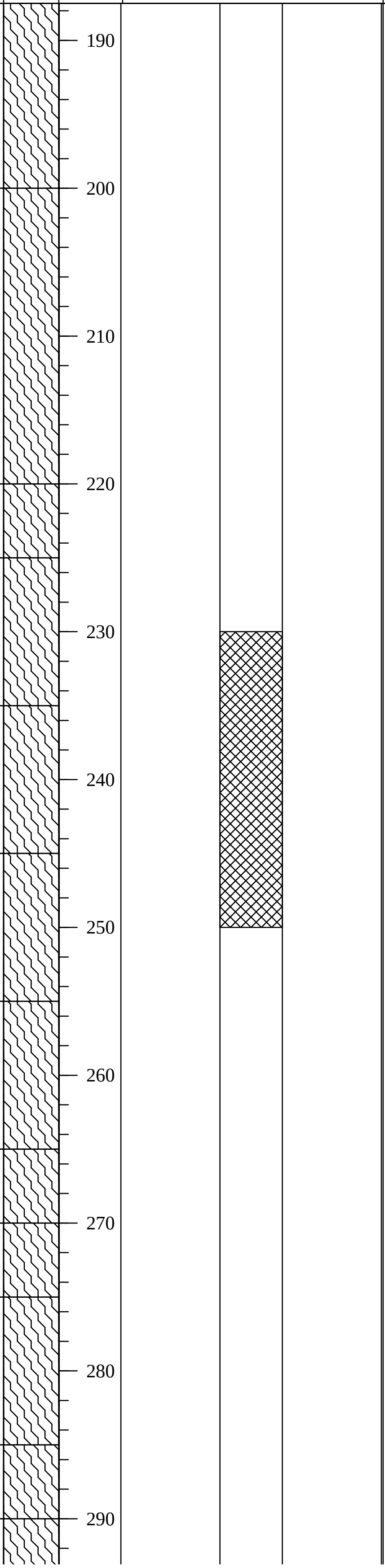
DEPTH FEET	BLOWN YIELD (GPM)	VOC (ppm)	LITHOLOGY	WELL CONSTRUCTION DETAILS
190	2 gpm	0	GNEISS: softer than above, with pink feldspar	
200			GNEISS: predominantly quartz and white feldspar, pink feldspar absent, harder formation, some greenish gray material	6" dia. air rotary borehole, 18' to 500'
220	2 gpm	0	GNEISS: dark greenish gray, micaceous, some quartz and feldspar	
			GNEISS: increase in feldspar and quartz to 50%	FLUTe Sample Port #230 sampling interval 230' - 250'
			GNEISS: greenish gray, micaceous, trace of quartz and pyrite	
	2-3 gpm	0	GNEISS: dark greenish gray with quartz, trace of white and pink feldspar, micaceous, no pink feldspar below 250'	
			GNEISS: increased quartz (50%), biotite-rich, trace of pink feldspar, some white feldspar, harder formation	
			GNEISS: increased greenish gray color, mica-rich	
270	3 gpm	0	GNEISS: quartz-rich with white feldspar, trace of iron-staining on fractures	
			GNEISS: very competent, decreased quartz, trace of feldspar	
			GNEISS: increased quartz and white feldspar, trace of iron-staining on quartz	
290			GNEISS: increased quartz content and pink feldspar, trace of pyrite	

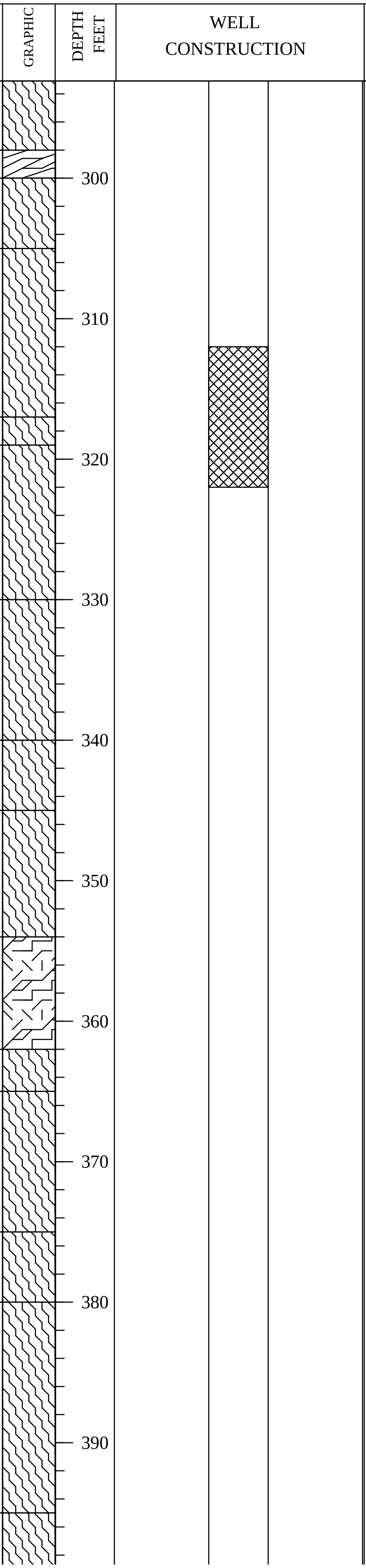


Revised 12/7/07

GROUNDWATER SCIENCES CORPORATION

GEOLOGIC LOG: SRMW-17R

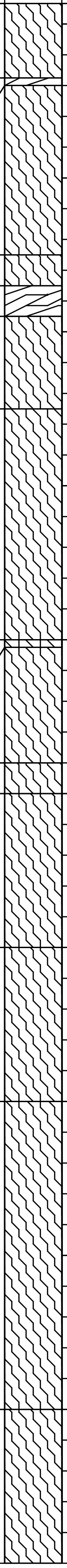
DEPTH FEET	BLOWN YIELD (GPM)	VOC (ppm)	LITHOLOGY	WELL CONSTRUCTION DETAILS
	3 gpm	0		
			FRACTURED GNEISS: softer zone	
300			GNEISS: pink feldspar and quartz-rich	
310			GNEISS: dark greenish gray, with quartz, trace of pink feldspar and pyrite, w/ biotite, some chlorite with quartz	FLUTe Sample Port #312 sampling interval 312' - 322'
			GNEISS: broken zone with larger cuttings	
320	3 gpm	0	GNEISS: dark greenish gray, pyrite-rich, trace of pink feldspar	
330			GNEISS: dark greenish gray with increased quartz content	
340			GNEISS: increased quartz and chlorite, some white feldspar	
350	3 gpm	0	GNEISS: dark greenish gray with quartz and pink feldspar	6" dia. air rotary borehole, 18' to 500'
360			PEGMATITE: abundant pink feldspar with quartz, some greenish gray material	
			GNEISS: greenish gray with quartz	
370	3 gpm	0	GNEISS: predominantly quartz with biotite, some white feldspar	
			GNEISS: decreasing quartz content, more biotite, trace of pyrite	
380 390			GNEISS: quartz-rich with increasing biotite and some chlorite	
	3 gpm	0	GNEISS: predominantly white feldspar and quartz, some biotite and chlorite	



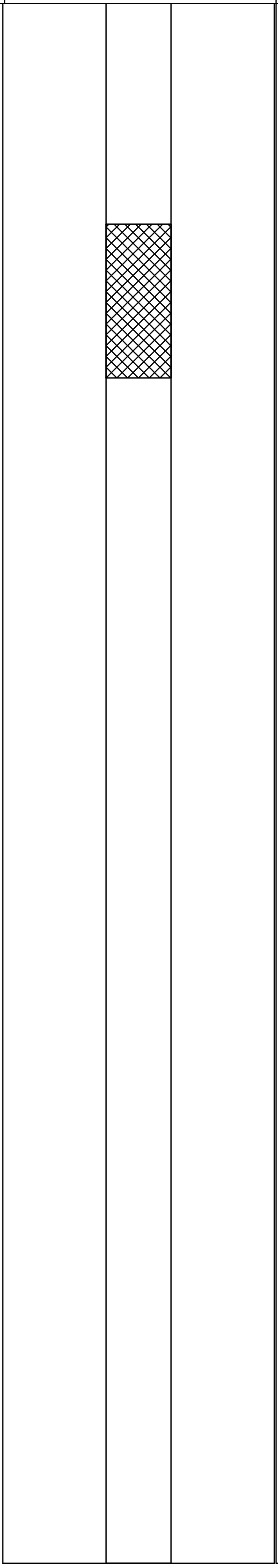
Revised 12/7/07

DEPTH FEET	BLOWN YIELD (GPM)	VOC (ppm)	LITHOLOGY	WELL CONSTRUCTION DETAILS
400				
			FRACTURED GNEISS: soft zone	
			GNEISS: more greenish gray, increased chlorite, some feldspar, trace of quartz	
410				
				FLUTe Sample Port #413 sampling interval 413' - 423'
	3 gpm	0	GNEISS: white feldspar and quartz, trace of biotite	
			FRACTURED GNEISS: soft zone	
420			GNEISS: quartz-rich	
			GNEISS: dark greenish gray some quartz, trace of pink feldspar, some zones of white feldspar	
430				
	3 gpm	0		
440			GNEISS: soft zone	
			GNEISS: predominantly white feldspar and quartz, some biotite	
			GNEISS: dark greenish gray	
450			GNEISS: white feldspar with quartz, some greenish gray, trace of pyrite	6" dia. air rotary borehole, 18' to 500'
	3 gpm	0		
460			GNEISS: dark greenish gray, biotite-rich, some quartz and feldspar, trace of pyrite, increased feldspar at 465'	
470			GNEISS: dark greenish gray, some quartz, trace of feldspar, trace of pyrite	
	3 gpm	0		
480				
490			GNEISS: predominantly white feldspar and quartz with biotite, greenish gray color at bottom with quartz and feldspar	
		0		
500	3 gpm	0		Total depth: 500 ft

GRAPHIC



WELL CONSTRUCTION



Final

GROUNDWATER SCIENCES CORPORATION

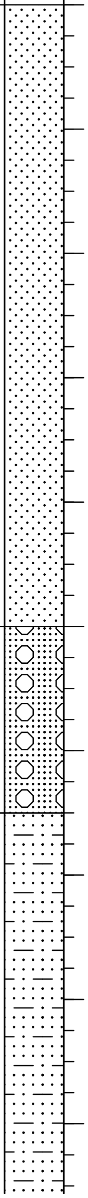
GEOLOGIC LOG: **SRMW-18 Core**

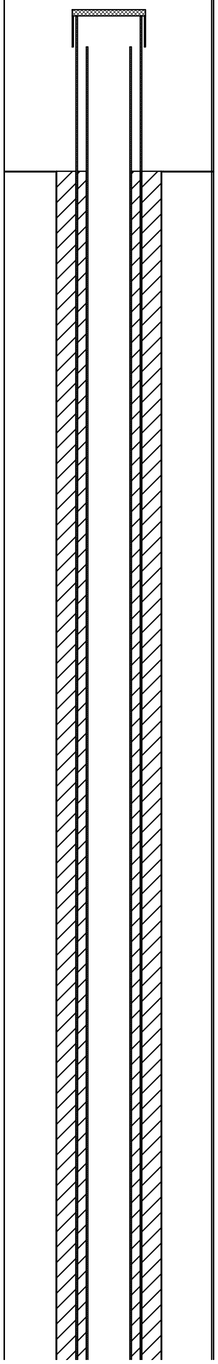
PROJECT INFORMATION		DRILLING INFORMATION	
PROJECT:	***Shenandoah***	DRILLING CO.:	***Eichelbergers, Inc.***
SITE LOCATION:	***Dutchess Co., New York***	DRILLER:	***R. Neidlinger***
JOB NO.:	***01003.11.0105***	RIG TYPE:	***CME-75***
LOGGED BY:	***E. Stoner/S. Fisher***	DRILLING METHOD:	***Hollow Stem Auger/Coring***
DATES DRILLED:	***11/16/05 - 11/29/05***	DEVELOPMENT DATE:	***12/2/05***
		LOCATION:	***Heitmann property, immediately N of site***

NOTES: SWL= 14.23 ft below TOC, 12/2/05
TOC elevation: approx. 507.5 ft amsl
Boring abandoned in 2006

SURFACE ELEV.	Approx. 505 ft amsl
EASTING	na
NORTHING	na

DEPTH FEET	RQD Value	VOC (ppm)	RECOV.	SAMP. #	SOIL/ROCK DESCRIPTION
2					
0	NA	---	---	---	SAND: brown, trace of silt and clay
10					SAND W/ GRAVEL: with cobbles, more difficult to auger
13					SAND & SILT: mixture of sand, silt, and clay, wet





WELL CONSTRUCTION DETAILS

6" locking well cap

10" dia. HSA borehole, 0'-25.5'

6" dia. steel casing, +2.5' to 25.5'

10" x 6" bentonite slurry annular seal, 0'-23'

4" dia.steel spin casing, +2' to 30'

6" x 4" bentonite slurry annular seal, 0'-25.5'

Final

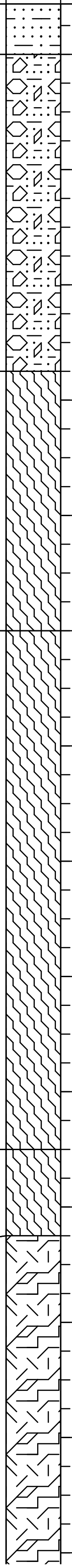
GROUNDWATER SCIENCES CORPORATION

PROJECT: ***Shenandoah***

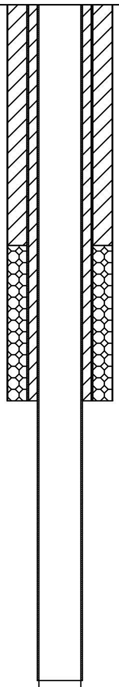
GEOLOGIC LOG: SRMW-18 Core

DEPTH FEET	RQD Value	VOC (ppm)	RECOV.	SAMP. #	SOIL/ROCK DESCRIPTION	WELL CONSTRUCTION DETAILS
20 22 24					SILT, SAND & GRAVEL: mixture of sand and gravel with cobbles at base, wet	10" x 6" bentonite slurry annular seal, 0'-23' 6" x 4" bentonite slurry annular seal, 0'-25.5' 10" x 6" bentonite chip annular seal, 23'-25.5'
26 28	89%	0	54"	1	GNEISS: biotite quartz gneiss with pyrite throughout, quartz-rich 25' 6" to 26' 8", foliated 26' 8" to 29' 5", then quartz-rich to 30', 60 deg. weathered fracture at 26' 9", 10 deg. weathered fracture at 27' 1', and 30 deg. weathered fracture at 28' 2"	4" dia.steel spin casing, +2' to 30'
30 32 34 36 38	94% (30' to 34') 90% (34' to 39')	0	108"	2	GNEISS: biotite quartz gneiss,75 deg fracture at 31' 5", weathered vertical fracture 33' to 34', highly fractured zone 34' to 34' 4", weathered vertical fracture 34' 4' to 34' 9", 35 deg. sealed fracture at 36' 9" parallel to foliation, weathered horizontal fracture at 37'	4" dia. HQ core borehole
40 42 44 46	78%	0	96"	3	GNEISS: biotite quartz gneiss, slightly weathered horizontal fracture at 39' 6", slightly weathered 10 deg. fracture at 40' 6" PEGMATITE: coarse crystalline, orthoclase and plagioclase feldspar-rich, with quartz and biotite, highly fractured zone 43' 9" to 45' 2", some loss of core sample in this interval, slightly weathered broken zone at 45' 9", several sealed fractures 46' 6" to 48'	

GRAPHIC



WELL CONSTRUCTION

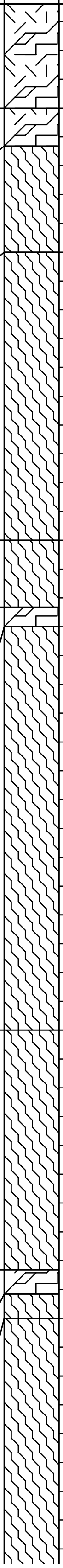


Final

GROUNDWATER SCIENCES CORPORATION

GEOLOGIC LOG: SRMW-18 Core

PROJECT: ***Shenandoah***



DEPTH FEET	RQD Value	VOC (ppm)	RECOV.	SAMP. #	SOIL/ROCK DESCRIPTION	WELL CONSTRUCTION DETAILS
48 50	77%	0	30"	4	PEGMATITE: as above, partially-sealed fracture at 48' 8", slightly weathered GNEISS: biotite quartz gneiss with granitic texture, 30 deg. slightly weathered fracture at 49' 4", broken zone with multiple fractures 49' 11" to 50' 6", horizontal to 40 deg. dips, slightly weathered	4" dia. HQ core borehole
52 54	50%	0	60"	5	GNEISS: biotite quartz gneiss, foliated, slightly weathered 60 deg. fracture at 50' 10", weathered horizontal fracture at 51' 9", slightly weathered 60 deg. fracture at 52' 4", horizontal fracture at 52' 8", heavily fractured zone 53' to 55' 6", apparent vertical fracture 53' to 53' 4", sealed fractures throughout	
56 58 60 62	95%	0	102"	6	GNEISS: biotite quartz gneiss, slightly weathered horizontal fracture at 56' 3", several sealed vertical fractures PEGMATITE: orthoclase and plagioclase feldspar lense, slightly weathered 45 deg. fracture at 56' 10" GNEISS: biotite quartz gneiss, weathered near-vertical fracture 57' to 57' 9", 45 deg. fracture at 58' 6', weathered vertical fracture from 58' 7" to 63' 9", 30 deg. fracture at 60' 1", 40 deg sealed fracture 60' 9" to 61', slightly weathered horizontal fracture at 61', highly fractured and weathered zone 63' 6" to 64'	
64 66 68	37%	0	60"	7	GNEISS: biotite quartz gneiss, sl weathered vertical fracture 64' to 64' 6", 25 deg fracture 64' 8", weathered horizontal fracture at 65', highly fractured and weathered zone 65' to 66', horizontal fracture at 66', highly fractured & weathered zone from 66' 6" to 68' 2", some partially-sealed fractures PEGMATITE: coarse crystalline, quartz and feldspar-rich	
70 72	38%	0	108"	8	GNEISS: fractured, unweathered biotite quartz gneiss GNEISS: biotite quartz gneiss, 40 deg. slickensided fracture at 71' 8", slightly weathered, heavily weathered and fractured 72' 6" to 78', some quartz-rich zones	

Final

GROUNDWATER SCIENCES CORPORATION

GEOLOGIC LOG: SRMW-18 Core

PROJECT: ***Shenandoah***

DEPTH FEET	RQD Value	VOC (ppm)	RECOV.	SAMP. #	SOIL/ROCK DESCRIPTION	WELL CONSTRUCTION DETAILS
74 76						4" dia. HQ core borehole
78 80 82	33%	0	60"	9	GNEISS: biotite quartz gneiss, highly weathered and fractured throughout interval, with sealed vertical fractures, slightly weathered vertical fracture 78' 4" to 80', highly weathered zone at 81' 4", slightly weathered horizontal fracture at 82' 4"	
84 86	73% (83' to 88')	0	120"	10	GNEISS: biotite quartz gneiss with quartz-rich zones 83' to 83' 10" and 84' 1" to 84' 3", 60 deg. slightly weathered fracture at 83' 4", nearly horizontal slightly weathered fracture at 84', 60 deg fracture at 84' 4", horizontal fractures at 84' 8" and 85' 4", 40 deg weathered fracture at 86', 70 deg. weathered fracture at 86' 2", weathered horizontal fracture at 86' 9", near-vertical weathered fracture 86' 9" to 87' 4", 60 deg. weathered fracture at 88'	
88 90 92	62% (88' to 93')				GNEISS: biotite quartz gneiss with quartz-rich zone 88' 10" to 89' 6", horizontal weathered fracture at 88' 9", multiple horizontal and partially-filled fractures 88' 10" to 90' 5", numerous microfractures, 50 deg. sealed fracture at 89' 4", 10 deg weathered fracture at 90' 1", horizontal weathered fracture at 90' 5", 60 deg. weathered fracture at 91' 7", highly fractured zone 91' 11" to 92' 4", quartz-rich 92' 5" to 92' 10"	
94 96	33%	0	48"	11	GNEISS: biotite quartz gneiss, 30 deg. partially-sealed fracture at 93' 3", moderately weathered and highly fractured zone 94' to 96' 5", heavily iron-stained at 96' 4", several horizontal and sealed fractures 96' 5" to 96' 9"	
98					GNEISS: 60 deg. partially-sealed iron-stained fracture at 97' 10" to 98' 3", slightly weathered horizontal fracture at 99' 2", fractured and slightly weathered 99' 2" to 99' 6"	
100					PEGMATITE: coarse crystalline, quartz and feldspar-rich	

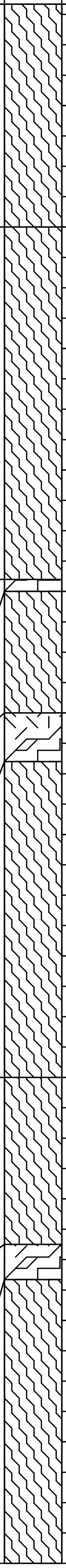
Final

GROUNDWATER SCIENCES CORPORATION

GEOLOGIC LOG: SRMW-18 Core

PROJECT: ***Shenandoah***

DEPTH FEET	RQD Value	VOC (ppm)	RECOV.	SAMP. #	SOIL/ROCK DESCRIPTION	GRAPHIC	DEPTH FEET	WELL CONSTRUCTION	WELL CONSTRUCTION DETAILS
102	62%	0	84"	12	GNEISS: biotite quartz gneiss, quartz-rich band at 100' 2", weathered horizontal fractures at 100' 3" and 100' 7", highly fractured zone 100' 7" to 101' 3", slightly weathered horizontal fracture at 101' 9", weathered horizontal fractures at 102' 3' and 102' 6", weathered fracture zone 103' to 104', deeply weathered at 103' 3"		102		4" dia. HQ core borehole
104 106 108	8%	0	60"	13	GNEISS: deeply weathered zone 104' to 106' 9", weathered horizontal fractures at 107', 107' 6", 107' 10", 50 deg. weathered fracture at 107' 3", near-vertical weathered fractures at 107' 8" and 108' 4", deeply weathered zone 108' 6" to 108' 10", 30 deg. fracture at 109' 4", 70 deg. fracture at 109' 7"		104 106 108		
110 112 114 116	73%	0	96"	14	PEGMATITE: coarse crystalline, quartz and feldspar-rich GNEISS: biotite quartz gneiss, 10 deg. weathered fracture at 110' 3", horizontal weathered fracture at 110' 6", 15 deg. weathered fracture at 111' 8" PEGMATITE: coarse crystalline, quartz and feldspar-rich, 70 deg. slightly weathered fracture at 112' 5" GNEISS: biotite quartz gneiss, weathered horizontal fractures at 113' 9", 114' 1", and 114' 11", several quartz-rich zones 116' to 118', weathered and fractured zone 117' to 118', multiple partially-sealed vertical and horizontal fractures		110 112 114 116		
118 120 122 124 126	57%	0	96"	15	GNEISS: biotite quartz gneiss, 60 deg. partially-sealed fracture at 118' 6", 60 deg. weathered fracture at 118' 9", quartz-rich zone 118' 11" to 119' 1", horizontal weathered fracture at 119' 1", horizontal fracture at 119' 11", highly fractured zone 119' 11" to 120' 3", 30 deg. fracture at 120' 7" PEGMATITE: coarse crystalline, quartz and feldspar-rich, quartz-rich 120' 9" to 121', 60 deg. fracture at 121' GNEISS: horizontal fracture in quartz-rich zone at 121' 6", wthrd horizontal fracture at 121' 10", 30 deg. fracture at 122', 70 deg. wthrd fracture at 122' 6", 30 deg. wthrd fracture at 123' 1", sl wthrd horizontal fracture at 123' 5", 60 deg. quartz band at 123' 7", 50 deg. quartz-sealed fracture at 123' 8", vertical wthrd fracture at 124' 1", fractured and wthrd zone 124' 1" to 126'		118 120 122 124 126		



Final 9/19/07

GROUNDWATER SCIENCES CORPORATION

GEOLOGIC LOG: SRMW-18RA

Page 1 of 1

PROJECT INFORMATION

PROJECT: *Shenandoah Road RI*
SITE LOCATION: *Town of East Fishkill, Dutchess Co., NY*
JOB NO.: *01003.11.0105*
LOGGED BY: *B. Titone*
DATES DRILLED: *2/13/07 - 2/16/07*

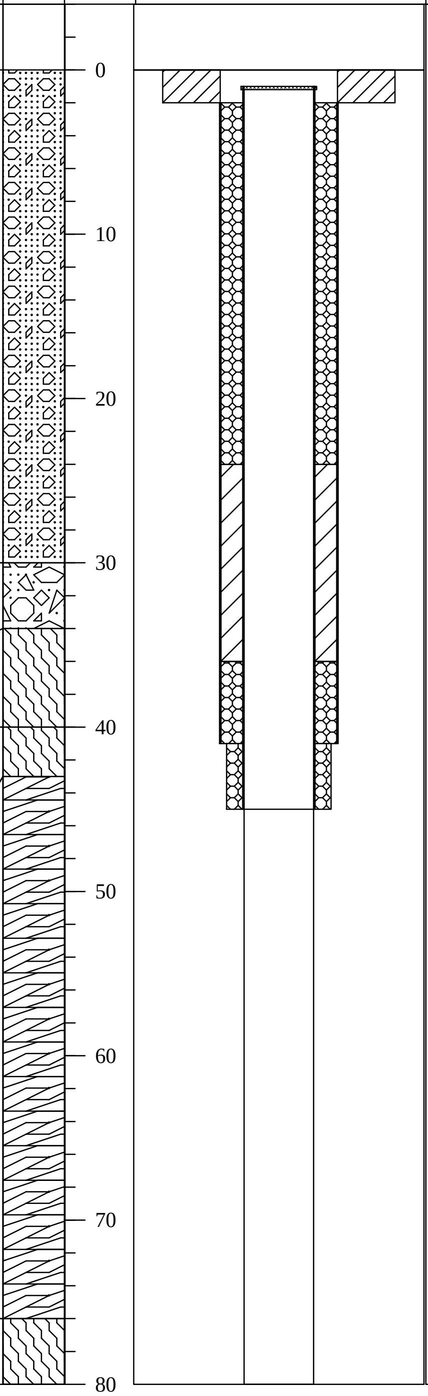
DRILLING INFORMATION

DRILLING CO.: *Eichelbergers, Inc.*
DRILLER: *C. Knaub*
RIG TYPE: *IR T4*
DRILLING METHOD: *Air Rotary*
DEVELOPMENT DATE: *NA*
LOCATION: *East Hook Cross Road, former excavation site*

NOTES: SWL: 19.54' below TOC, 4/25/07
TOC elevation: 503.38 ft amsl
FLUTe installed July 2007

SURFACE ELEVATION: 504.56 ft amsl
NORTHING: 981831.41 EASTING: 685681.43

DEPTH FEET	CUM. BLOWN YIELD	VOC (ppm)	LITHOLOGY
0			SAND & GRAVEL: dark yellowish brown, little sand, boulder at 0.5'-2.5', heavy gravel and granules bottom 5 feet
10			
20			
30			GRAVEL: grayish olive, large gravel with granules, little silt, trace sand, various lithologies. angular to subround gravel.mostly gravel near bottom.
			GNEISS: white to black iron-stained fracture surfaces, occ. medium quartz and pink feldspar masses, partly weathered, possiblemuddy WBZ @36'
40			GNEISS: white to black, speckeled, banded, pink feldspar, smoky qtz, biotite, partly weathered, iron fracture stains
	0 gpm	0	FRACTURED GNEISS: heavily weathered, iron-stained fracture surfaces, conjugate fracture planes, dark yellowish brown to olive gray mud,very soft drilling
50			
60			
70	~0.5 gpm	0	
			GNEISS: light gray to dark greenish gray, speckled, banded, competent
80	~0.5 gpm		



WELL CONSTRUCTION DETAILS

Flushmounted manhole w/ 6" sealing/locking well cap

Bentonite chip 9"x6" annular seal, 2' - 24'

Bentonite slurry 10"x6" annular seal, 24' - 36'

10" dia steel casing with STRADEX drive shoe, 2' - 41'

6" dia. steel casing with drive shoe and centralizers, 1' - 45'

Bentonite chip 9"x6" annular seal, 36' - 45'

6" dia. air rotary borehole, 45' - 80'

Revised 12/7/07

GROUNDWATER SCIENCES CORPORATION

GEOLOGIC LOG: SRMW-18RB

Page 1 of 2

PROJECT INFORMATION

PROJECT: ***Shenandoah Road RI***
SITE LOCATION: ***Town of East Fishkill, Dutchess Co., NY***
JOB NO.: ***01003.11.0105***
LOGGED BY: ***B. Titone***
DATES DRILLED: ***11/20/06 - 2/12/07***

DRILLING INFORMATION

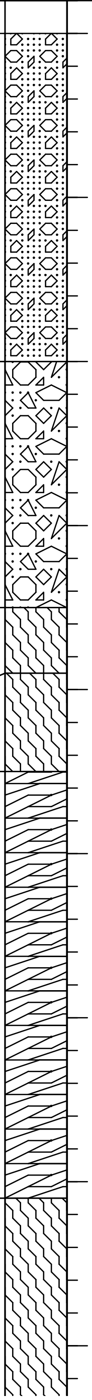
DRILLING CO.: ***Eichelbergers, Inc.***
DRILLER: ***C. Knaub***
RIG TYPE: ***IR T4***
DRILLING METHOD: ***Air Rotary***
DEVELOPMENT DATE: ***NA***
LOCATION: ***East Hook Cross Road, former excavation site***

NOTES: SWL: 10.15', 4/25/07, deepened from 124' to 160' on 2/12/07
TOC elevation: 503.17 ft amsl
FLUTe system installed July 2007

SURFACE ELEVATION: 504.28 ft amsl
NORTHING: 981842.98 EASTING: 685682.74

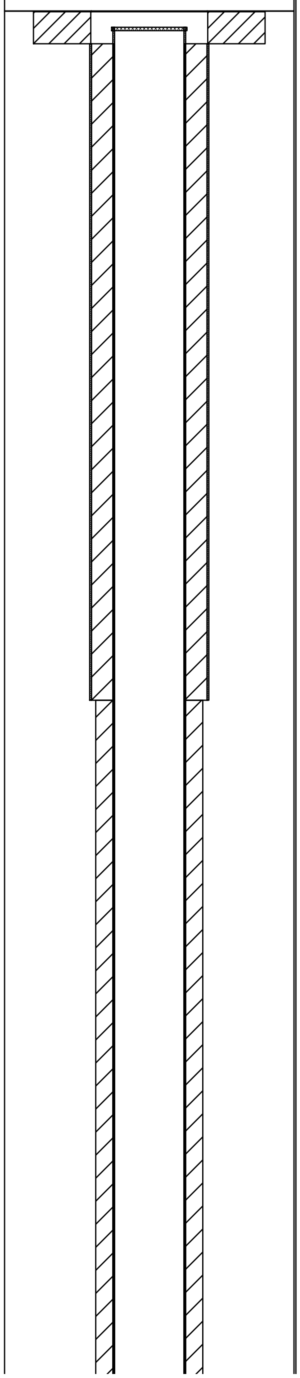
DEPTH FEET	CUM. BLOWN YIELD	VOC (ppm)	LITHOLOGY	WELL CONSTRUCTION DETAILS
0			SAND & GRAVEL: brown,some gravel, little silt	Flushmounted manhole w/ 6" sealing/locking well cap
10				
20			GRAVEL: grayish olive, large gravel with granules, little silt, trace sand, various lithologies. angular to subround gravel.mostly gravel near bottom.	Bentonite slurry 10"x6" annular seal, 2' - 42'
30				
			GNEISS: broken/weathered, white to black iron-stained fracture surfaces, occ. medium quartz and pink feldspar masses	10" dia steel casing with STRADEX drive shoe, 2' - 42'
40			GNEISS: white to black, speckeled, banded, occ. pegmatitic zones, pink feldspar, smoky qtz, biotite, partly weathered	
	> 1 gpm	0	FRACTURED GNEISS: heavily weathered, iron-stained fracture surfaces, conjugate fracture planes, saprolitic material with relict rockfabric, orange muddy water, very soft drilling, WBZ@ 66'	
50				
				Bentonite slurry 9.25"x6" annular seal, 2' - 95'
60				
70				6" dia. steel casing with drive shoe and centralizers, 1' - 101'
	1.5 - 2 gpm	0	GNEISS: hard, white to black, trace pegmatitic material, trace graphic granite texture	
80				

GRAPHIC



DEPTH FEET

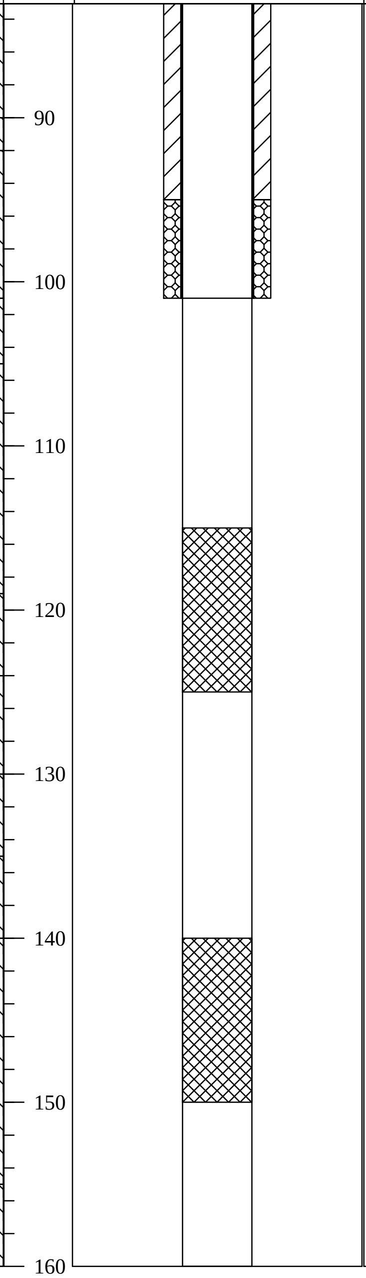
WELL CONSTRUCTION



Revised 12/7/07

DEPTH FEET	BLOWN YIELD (GPM)	VOC (ppm)	LITHOLOGY
90			GNEISS: white, little black, quartz dominated
100	1.5 - 2 gpm	0	GNEISS: black to white, trace pyrite, biotite/hornblende present
	1.5 - 2 gpm	0	GNEISS: greenish black to light olive gray, speckled, banded, pyrite, olivine?
110			GNEISS: greenish black to dark green, speckled, trace pyrite, some light olive gray, tr. iron fracture staining/skin, fracture@108', 117', WBZ @117'- muddy
120	3 gpm	17 5	GNEISS: dark greenish gray to light olive gray, speckled, banded, soliated, pyrite, light mica (muscovite?), iron fracturestaining
	3 gpm		GNEISS: light olive gray to medium gray, speckeled, trace pyrite, trace iron stained fracture surfaces
130			GNEISS: medium gray, foliated, trace pyrite, "shaley" appearance, much iron stained frature surfaces, WBZ @ 132'-135'
			GNEISS: medium gray, foliated, trace pyrite, "shaley" appearance, bands of light olive gray speckled
140 150	4-5 gpm	0	GNEISS: medium gray, speckled, banded with light olive gray, some lighter zones, trace pyrite, iron staining, possible WBZ @155'
160			GNEISS: medium gray, foliated, trace pyrite, "shaley" appearance , banded with light olive gray and quartz rich zones, traceiron staining

WELL CONSTRUCTION



WELL CONSTRUCTION DETAILS

Bentonite slurry 9.25"x6" annular seal, 2' - 95'

Bentonite chip 9.25"x6" annular seal, 95' - 101'

FLUTe Sample Port #115 sampling interval 115' - 125'

6" dia. air rotary borehole, 101' - 160'

FLUTe Sample Port #140 sampling interval 140' - 150'

Revised 12/7/07

GROUNDWATER SCIENCES CORPORATION

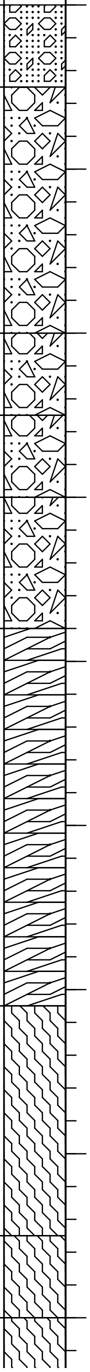
GEOLOGIC LOG: SRMW-18RC

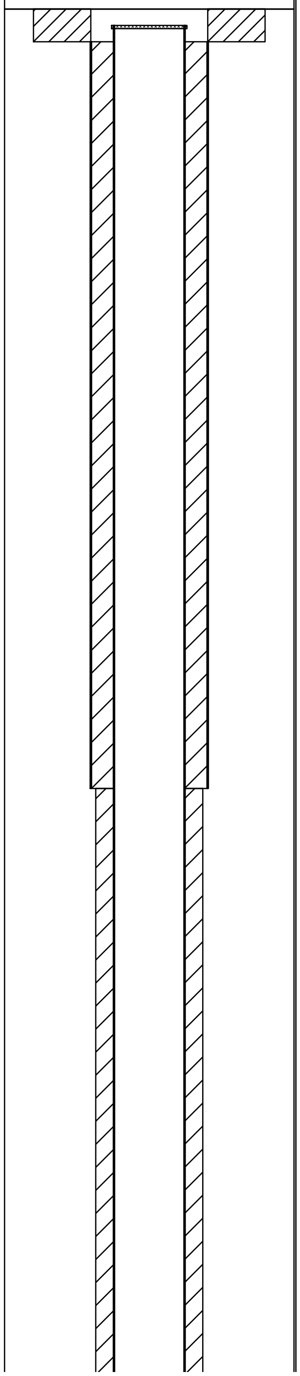
Page 1 of 3

PROJECT INFORMATION		DRILLING INFORMATION	
PROJECT:	***Shenandoah Road RI***	DRILLING CO.:	***Eichelbergers, Inc.***
SITE LOCATION:	***Town of East Fishkill, Dutchess Co., NY***	DRILLER:	***C. Knaub***
JOB NO.:	***01003.11.105***	RIG TYPE:	***IR T4***
LOGGED BY:	***B. Titone***	DRILLING METHOD:	***Air Rotary***
		DEVELOPMENT DATE:	***NA***
DATES DRILLED:	***11/28/06 - 12/11/06***	LOCATION:	***East Hook Cross Road, former excavation site***

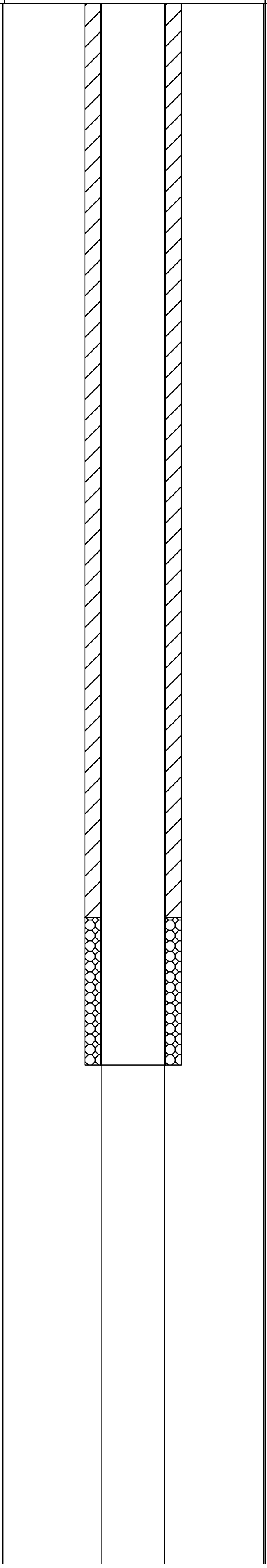
NOTES: SWL: 27.03' below TOC, 4/25/07
TOC elevation: 503.19 ft amsl
FLUTe system installed July 2007

SURFACE ELEVATION: 504.46 ft amsl
NORTHING: 981846.47 EASTING: 685675.83





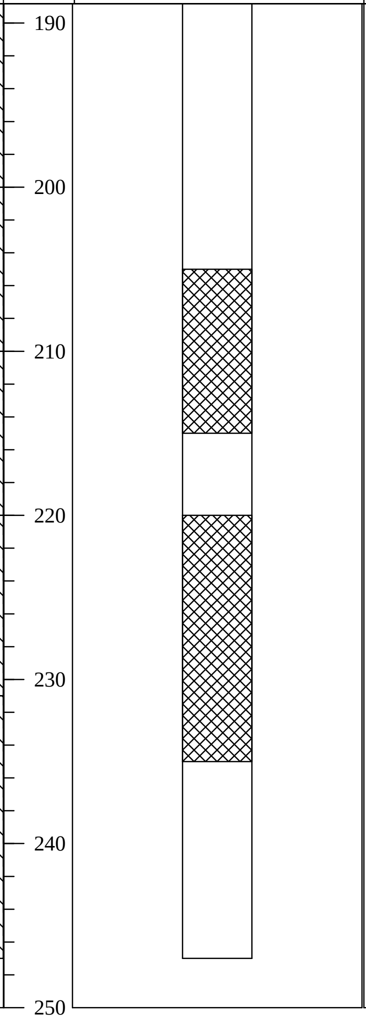
DEPTH FEET	CUM. BLOWN YIELD	VOC (ppm)	LITHOLOGY	DEPTH FEET	WELL CONSTRUCTION DETAILS
0			SAND & GRAVEL: dark yellowish brown (10 YR 4/2), little silt GRAVEL: little silt, trace sand, angular-subangular gravel of various lithologies, dark yellowish orange (10 YR 6/6) silt,occasional large boulder	0	Flushmounted manhole w/ 6" sealing/locking well cap
10				10	10" dia.steel casing with STRADEX drive shoe, 2' - 47.5'
20			GRAVEL: some silt and sand, olive gray (5 Y 3/2), ang-suba gravel GRAVEL: some silt and sand, medium gray (N5)	20	
30			GRAVEL: some silt and sand, olive gray	30	Bentonite slurry 10"x6" annular seal, 2' - 47.5'
40			FRACTURED GNEISS: fractured/ weathered, light olive gray (5 Y 5/2) to olive gray, coarse crystalline, iron staining, speckles/bands	40	
50				50	6" dia. steel casing with drive shoe and centralizers, 1' - 155'
60			GNEISS: greenish black (5 G 2/1) with white (N9) speckles/bands, common biotite/quartz, slightly foliated, trace pyrite	60	9.25" dia. air rotary borehole, 47.5' - 155'
70	> 0.1 gpm	7.9	GNEISS: light gray to light olive gray with black speckles, color mass variations, trace pyrite, banded	70	Bentonite slurry 9.25"x6" annular seal, 47.5' - 145'
80			GNEISS: light gray/olive to black, banded/speckled, trace pyrite, biotite/hornblende common,	80	



DEPTH FEET	BLOWN YIELD (GPM)	VOC (ppm)	LITHOLOGY	WELL CONSTRUCTION DETAILS
			medium-coarse grained, more pyrite around 90'-100'	
90				9.25" dia. air rotary borehole, 47.5' - 155'
	>0.25 gpm	21		
100				
			GNEISS: greenish black, some minor lighter bands, trace pyrite, some small biotite/hornblende crystals, trace rosy quartz,foliated, med-fine grained, iron stained fracture surfaces, some pyrite rich zones, FRACTURES: 107', 111', 115', 123'	
110				6" dia. steel casing with drive shoe and centralizers, 1' - 155'
120	>0.25 gpm	3.1		
			GNEISS: Dark greenish gray (5 GY 4/1) to light olive gray, more color variation, iron stained fracture surfaces, slightly foliated/banded, pyrite, FRACTURES: 131'	
130				Bentonite slurry 9.25"x6" annular seal, 47.5' - 145'
			GNEISS: dark greenish gray, highly foliated, iron stained fractures common, FRACTURES: 136', 144'	
140				
	> 1 gpm	0	GNEISS: dark greenish gray to light olive gray, banded, slightly foliated, speckled, much color variation, iron stained fractures	
150				Bentonite chip 9.25"x6" annular seal, 145' - 155'
			GNEISS: dark gray (N2) to light olive gray, slightly foliated/banded, trace pyrite, biotite, less foliated below 160', speckled	
160				
			GNEISS: speckled dark gray (N3) and light olive gray, trace banding, trace pyrite, light material 166'-167'	6" dia. air rotary borehole, 155' - 247'
170			GNEISS: mixed dark gray and light olive gray, trace pyrite, trace biotite/phlogopite	
			GNEISS: grayish pink (5 R 8/2), black specks, turns to pinkish gray (5 YR 8/1) from 180'-185'	
180				
			GNEISS: medium dark gray to light olive gray, speckled, trace pyrite, more light 195'-200'	

GEOLOGIC LOG: SRMW-18RC

DEPTH FEET	BLOWN YIELD (GPM)	VOC (ppm)	LITHOLOGY	WELL CONSTRUCTION DETAILS
190				
	0 gpm	0		6" dia. air rotary borehole, 155' - 247'
200			GNEISS: medium gray (N5) to greenish gray (5 GY 6/1) with light olive gray, speckled, dark specks, trace pyrite/chalcopyrite, slightly foliated, trace iron fracture staining	
				FLUTe Sample Port #205 sampling interval 205' - 215'
210			GNEISS: dark greenish gray, slightly dusky blue (5 PB 3/2), foliated, slightly schistose, biotite specks, trace pyrite, ironstained fracture surfaces, FRACTURE: 212'	
220	4 gpm	0	GNEISS: weathered, dark gray to light olive gray, some pink feldspar, iron staining, much pyrite/magnetite, some coarse crystalline quartz, biotite, calcite, FRACTURE: 223' - 226'	FLUTe Sample Port #220 sampling interval 220' - 235'
	7 gpm			
230				
			GNEISS: dark gray to light olive gray, slightly foliated, speckled, trace pyrite	
240				
	~10 gpm	0		
250				



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GROUNDWATER SCIENCES CORPORATION

GEOLOGIC LOG: SRMW-18RD

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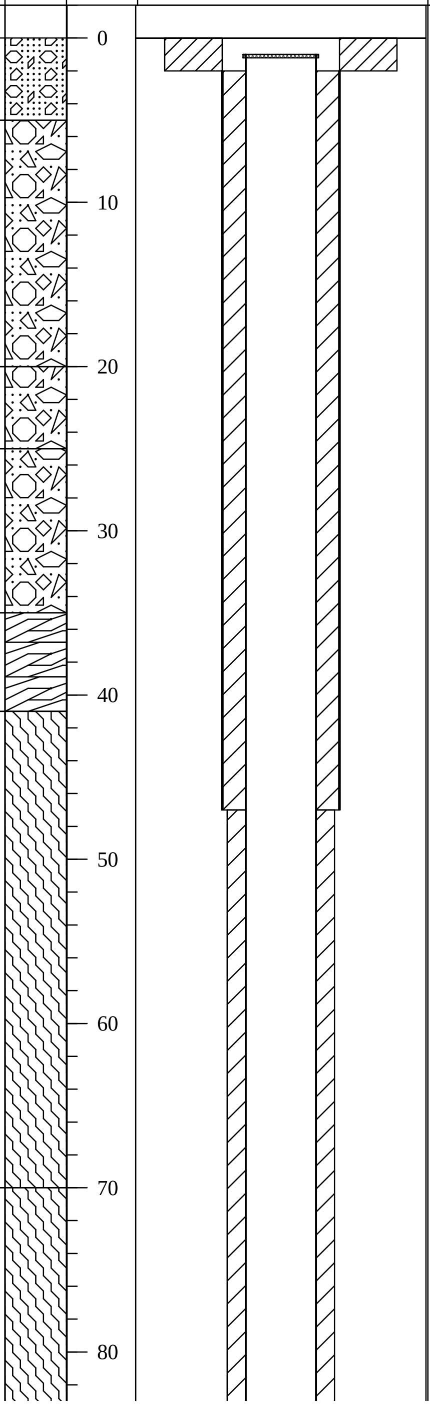
PROJECT INFORMATION		DRILLING INFORMATION	
PROJECT:	***Shenandoah Road RI***	DRILLING CO.:	***Eichelbergers, Inc.***
SITE LOCATION:	***Town of East Fishkill, Dutchess Co., NY***	DRILLER:	***C. Knaub***
JOB NO.:	***01003.11.0105***	RIG TYPE:	***IR T4***
LOGGED BY:	***B. Titone***	DRILLING METHOD:	***Air Rotary***
		DEVELOPMENT DATE:	***NA***
DATES DRILLED:	***12/12/06 - 12/22/06***	LOCATION:	***East Hook Cross Road, former excavation site***

NOTES: SWL: 66.42' below TOC 1/4/07
TOC elevation: 503.51 ft amsl
Open borehole

SURFACE ELEVATION: 504.62 ft amsl
NORTHING: 981850.30 EASTING: 685668.73

DEPTH FEET	CUM. BLOWN YIELD	VOC (ppm)	LITHOLOGY
0			SAND & GRAVEL: moderate yellowish brown (10YR 5/4), little silt
			GRAVEL: little silt, trace sand, angular-subangular gravel of various lithologies, dark yellowish orange (10YR 6/6) silt,occasional large boulder
10			
20			GRAVEL: some silt and sand, olive gray (5Y 3/2) angular-subangular gravel
			GRAVEL: some silt and sand, light gray to light olive gray(N6 to 5Y 6/1)
30			
			FRACTURED GNEISS: fractured/ weathered, yellowish gray (5Y 8/1) with dark and translucent bands, saprolite nodules, medium grained,some pyrite
40			
			GNEISS: blackish gray(N2) to yellowish gray, speckled/banded, trace pyrite, pink feldspar, some lighter feldspar around 55'
50			
60			
70	> 0.1 gpm	0	GNEISS: dark greenish gray (5GY 4/1) to light olive gray, foliated, biotite speckle, trace pink feldspar, slightly schistose,some areas of lighter rock, trace pyrite
80			



WELL CONSTRUCTION DETAILS

Flushmounted manhole w/ 6" sealing/locking cap

10" dia. steel casing with STRADEX drive shoe, 2' - 47'

Bentonite slurry 10"x6" annular seal, 2' - 47'

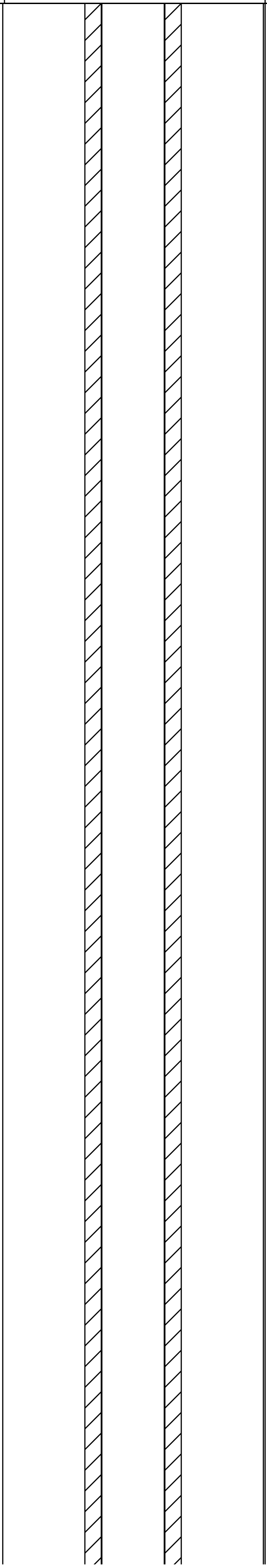
9.25" dia. air rotary borehole, 47' - 247'

Bentonite slurry 9.25"x6" annular seal, 47' - 237'

6" dia. steel casing with drive shoe and centralizers, 1' - 247'

DEPTH FEET	BLOWN YIELD (GPM)	VOC (ppm)	LITHOLOGY	WELL CONSTRUCTION DETAILS
90				
100	>0.25 gpm	0	GNEISS: light gray (N8)/ light olive gray to black(N1), banded/speckled, trace pyrite, biotite/hornblende common, med.-coarsegrained, more pyrite around 90'-100'	9.25" dia. air rotary borehole, 47' - 247'
110 120	>1 gpm	0	GNEISS: dark greenish gray, minor moderate yellowish green(5GY 7/4), foliated, dark specks, hornblende, trace pyrite withbiotite, "shaly" in appearance, iron fracture staining (110-115) tr. pink feldspar, minor fracture @ 125'	
130			FRACTURED GNEISS: weathred/fractured, dark gray (N2) to white (N9), iron staining, slightly foliated, biotite, trace pyrite, secondarypyrite/ translucent quartz, slickensides	
			GNEISS: greenish gray (5GY 6/1) to moderate yellowish green (10GY 6/4), speckled, slightly foliated, tace. pyrite, biotite,light/dark zones	
140			FRACTURED GNEISS: weathered/fractured, foliated, slightly schistose, medium gray (N4), layered, shiny, slightly mylonitic, iron stainedfractures. secondary quartz/pyrite	Bentonite slurry 9.25"x6" annular seal, 47' - 237'
	8 gpm	0	GNEISS: medium gray to light olive gray, speckled, biotite, lighter zone 145'-150'	
150			GNEISS: dark greenish gray, slightly foliated, biotite specks, possible FRACTURES148'-151'	
160 170	8 gpm	0	GNEISS: light olive gray to dark greenish gray, speckled, banded, slight foliation, trace pink feldspar, iron staining(160'-162')	6" dia. steel casing with drive shoe and centralizers, 1' - 247'
180			GNEISS: grayish pink (5R 8/2) to pale red (10R 6/2), biotite bands/specks, occasional pink feldspar phenocryst	

WELL CONSTRUCTION



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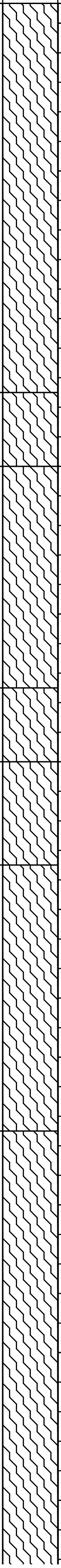

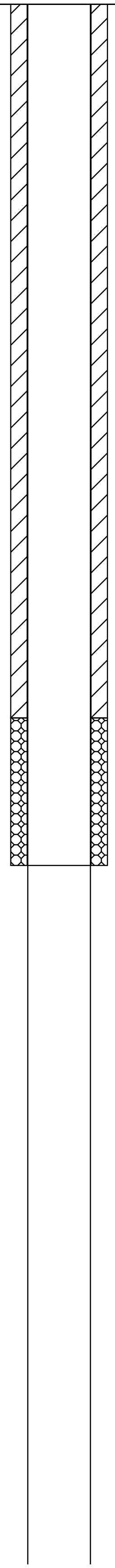

DEPTH FEET	BLOWN YIELD (GPM)	VOC (ppm)	LITHOLOGY	WELL CONSTRUCTION DETAILS
190			GNEISS: dark greenish gray to light gray, slightly foliated. biotite flecks, trace pyrite, occasional white to light greenishgray zones, iron-stained fractures, trace pink feldspar (200'-205') FRACTURE: 211'-213'	
	8-10 gpm	0		
200				9.25" dia. air rotary borehole, 47' - 247'
210				
	~10 gpm	0		
			GNEISS: dark gray, biotite flecks, light yellowish gray to white zone 216'-218'	Bentonite slurry 9.25"x6" annular seal, 47' - 237'
220	~10 gpm	0	GNEISS: medium gray to olive green, some translucent white, pink fledspar, trace chalcopyrite/pyrite/magnetite, biotote flecks	
230				6" dia. steel casing with drive shoe and centralizers, 1' - 247'
			GNEISS: medium gray to olive gray, slightly foliated, trace biotite	
240			GNEISS: greenish gray with light/dark variations, biotite, trace pyrite, light/dark med. coarse crystalline zones, trace pinkfeldspar, FRACTURE @ 241' w/ iron-stained surfaces	Bentonite chip 9.25"x6" annular seal, 237' - 247'
	10-12 gpm	0		
250			GNEISS: greenish gray with light/dark variations, biotite, trace calcite, trace pyrite, light/dark medium coarse crystallinezones, trace pink feldspar	
260				
			GNEISS: dark grayish green with light speckles/bands, light/dark zones, trace pink feldspar, slight foliation, trace pyrite,trace muscovite, trace large biotite (5mm)	6" dia. air rotary borehole, 247' - 320'
270	0 gpm	0		
280				
	1.5 gpm	0		
290				

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DEPTH FEET	BLOWN YIELD (GPM)	VOC (ppm)	LITHOLOGY	GRAPHIC	DEPTH FEET	WELL CONSTRUCTION	WELL CONSTRUCTION DETAILS
	1.5 - 2 gpm	0		▨			
300					300		6" dia. air rotary borehole, 247' - 320'
			GNEISS: dusky yellow green (10GY 3/2) to light olive green, spotted/banded, dark specks, light/dark zones, trace pyrite, trace muscovite	▨			
310					310		
320	1.5 - 2	0			320		

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GROUNDWATER SCIENCES CORPORATION

GEOLOGIC LOG: SRMW-18RE

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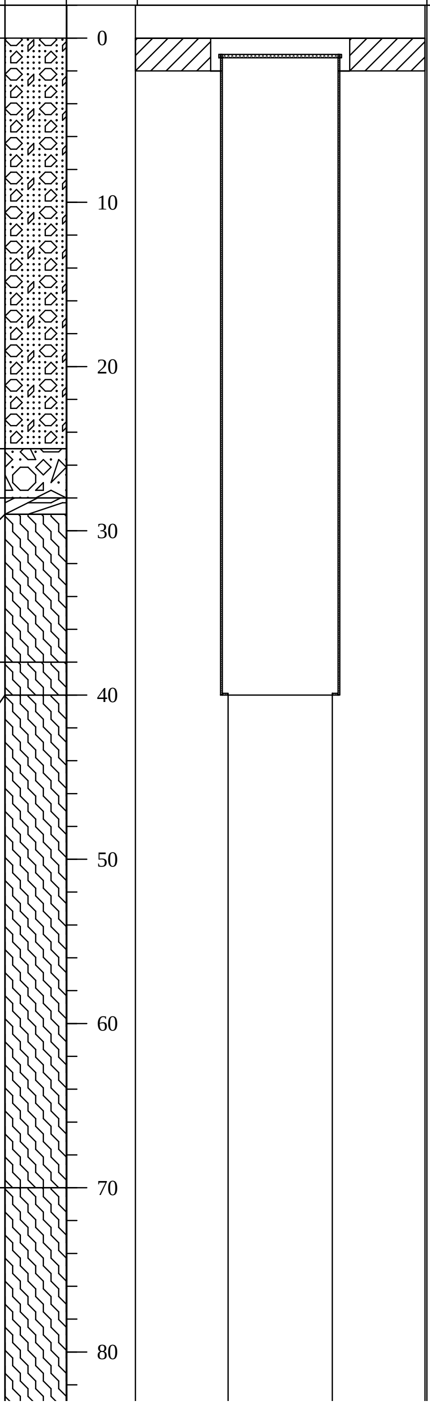
PROJECT INFORMATION		DRILLING INFORMATION	
PROJECT:	***Shenandoah Road RI***	DRILLING CO.:	***Eichelbergers, Inc.***
SITE LOCATION:	***Town of East Fishkill, Dutchess Co., NY***	DRILLER:	***C. Knaub***
JOB NO.:	***01003.11.0105***	RIG TYPE:	***IR T4***
LOGGED BY:	***B. Titone***	DRILLING METHOD:	***Air Rotary***
		DEVELOPMENT DATE:	***NA***
DATES DRILLED:	***1/2/07 - 1/04/07***	LOCATION:	***East Hook Cross Road, former excavation site***

NOTES: SWL: 21.16' below TOC 1/17/07, 12:22
TOC elevation: 503.56 ft amsl
Temporary blank FLUTe liner installed

SURFACE ELEVATION: 504.73 ft amsl
NORTHING: 981853.06 EASTING: 685661.32

DEPTH FEET	CUM. BLOWN YIELD	VOC (ppm)	LITHOLOGY	WELL CONSTRUCTION DETAILS
0			SAND & GRAVEL: quartzite boulder 6-8'	Flushmounted manhole w/ 10" sealing/locking well cap
			GRAVEL: mixed lithologies	
			FRACTURED GNEISS: weathered	
30			GNEISS: fairly competent, weathered zone @ 35-38 FRACTURE @ 35'	10" dia. steel casing with STRADEX drive shoe, 1' - 40'
			GNEISS: pegmatitic gneiss with feldspar, biotite and quartz	
40	0.5-1 gpm		GNEISS: dark greenish gray (5GY 4/1) to pale greenish yellow (10Y 8/2), albite and plagioclase rich, minor biotite, tracepyrite, some qtz, trace plagioclase below 45', speckled, banded, finer grained with depth	
70	0.5-1 gpm	0	GNEISS: blebby, medium grained grayish black (N2) to pale greenish yellow, trace pyrite, trace pink feldspar, more fine-grained, banded, speckled FRACTURES @ 71', 74'-75'	9" dia. air rotary borehole, 40' - 275'



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DEPTH FEET	BLOWN YIELD (GPM)	VOC (ppm)	LITHOLOGY	GRAPHIC	DEPTH FEET	WELL CONSTRUCTION	WELL CONSTRUCTION DETAILS
90	1 gpm	0			90		
100 110 120 130	1 gpm	0	GNEISS: alternating dark greenish gray and yellowish gray (5Y 8/1), banded, more foliated, trace pyrite, speckled, light/dark banding ends below 110, heavier foliation and greenish black (5GY 5/1) below 110, FRACTURES @ 112', 127-130', 134',139', WBZ @ 127-130'		100 110 120 130		9" dia. air rotary borehole, 40' - 275'
140 150	2-2.5 gpm	0	GNEISS: dark greenish gray, more foliated, much iron staining, trace pyrte, alternate light and dark bands from 145'-160',FRACTURES @ 144', 155', WBZ @ 155'		140 150		
160			GNEISS: brownish gray (5YR 4/1) to pale red (10R 6/2) and pinkish gray (5YR 8/1), finer grained with speckles and dark bands		160		
170	5-6 gpm	0	GNEISS: alternating pale greenish yellow and greenish black, speckled, some milky quartz, trace pyrite		170		
180			GNEISS: mixed pinkish gray and greenish black with yellwish gray, speckled, trace pyrite, FRACTURE @ 178'		180		
			GNEISS: alternating pale greenish yellow and lesser greenish black, speckled, some milky quartz, trace				

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GROUNDWATER SCIENCES CORPORATION

GEOLOGIC LOG: **SRMW-18RE**

DEPTH FEET	BLOWN YIELD (GPM)	VOC (ppm)	LITHOLOGY	WELL CONSTRUCTION DETAILS
190				
	5-6 gpm	0	GNEISS: grayish black, some lighter, trace pyrite, foliated, some iron staining, trace pink feldspar, large returns from 215'-225' FRACTURE @ 214', 217'-218', 227'-233', 236'-238', 240'-245', WBZ @ 214', 233', 240'-245'	
200				9" dia. air rotary borehole, 40' - 275'
210				
		0		
220	7-8 gpm	0		
230				
240				
	10-12 gpm	0	GNEISS: dark greenish gray to dark gray (N3), trace pyrite, large returns 245'-260'., FRACTURES @ 245'-251', WBZ @ 245'	
250				
260				
			GNEISS: dark greenish gray to dark gray (N3),more frequent pale greenish yellow bands, trace pyrite, trace pink feldspar	
270	12-15 gpm	0		
280				

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GROUNDWATER SCIENCES CORPORATION

GEOLOGIC LOG: SRMW-18RF

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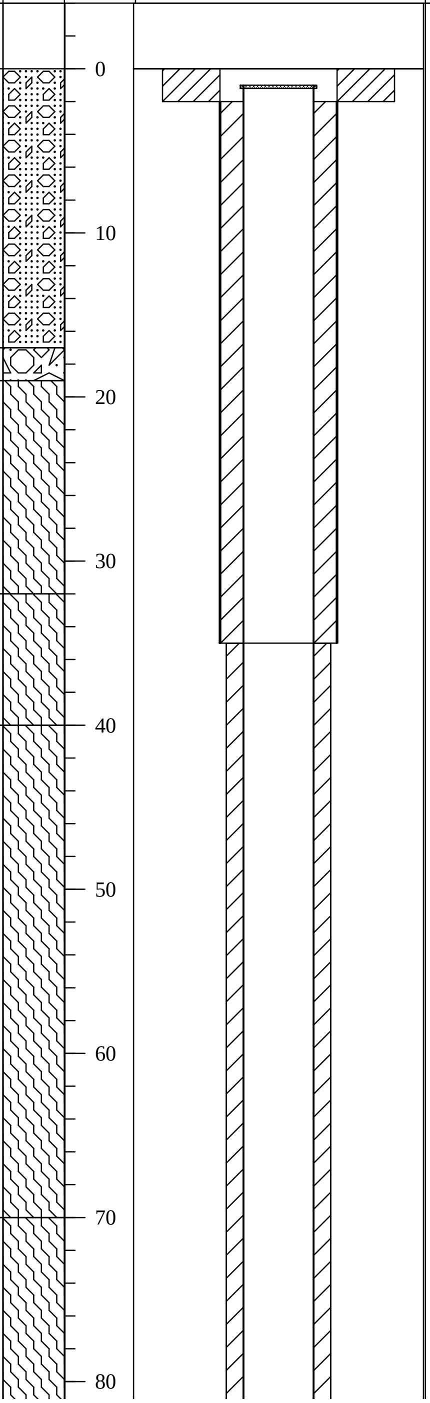
PROJECT INFORMATION		DRILLING INFORMATION	
PROJECT:	***Shenandoah Road RI***	DRILLING CO.:	***Eichelbergers, Inc.***
SITE LOCATION:	***Town of East Fishkill, Dutchess Co., NY***	DRILLER:	***C. Knaub***
JOB NO.:	***01003.11.0105***	RIG TYPE:	***IR T4***
LOGGED BY:	***B. Titone***	DRILLING METHOD:	***Air Rotary***
		DEVELOPMENT DATE:	***NA***
DATES DRILLED:	***1/5/07 - 2/02/07***	LOCATION:	***East Hook Cross Road, former excavation site***

NOTES: SWL: 48.0' below TOC, 7/20/07
TOC elevation: 503.95 ft amsl
FLUTe system installed July 2007

SURFACE ELEVATION: 505.03 ft amsl

NORTHING: 981856.24 EASTING: 685653.96

DEPTH FEET	CUM. BLOWN YIELD	VOC (ppm)	LITHOLOGY
0			SAND & GRAVEL: dark yellowish brown (10 YR 5/6) boulder @ 6'
10			
			GRAVEL: with rock chips, sloped bedrock surface
20			GNEISS: pegmatitic, large plagioclase and biotite, more albite rich at bottom
30			
			GNEISS
40			GNEISS
	0 gpm	0	
50			
60			
70	0 gpm	0	GNEISS
80			



WELL CONSTRUCTION DETAILS

Flushmounted manhole w/ 6" sealing/locking well cap

10" dia. steel casing with STRADEX drive shoe, 2' - 35'

Bentonite slurry 10"x6" annular seal, 2' - 35'

9" dia. air rotary borehole, 35' - 320'

Bentonite slurry 9"x6" annular seal, 35' - 318'

6" dia. steel casing with drive shoe and centralizers, 1' - 320'

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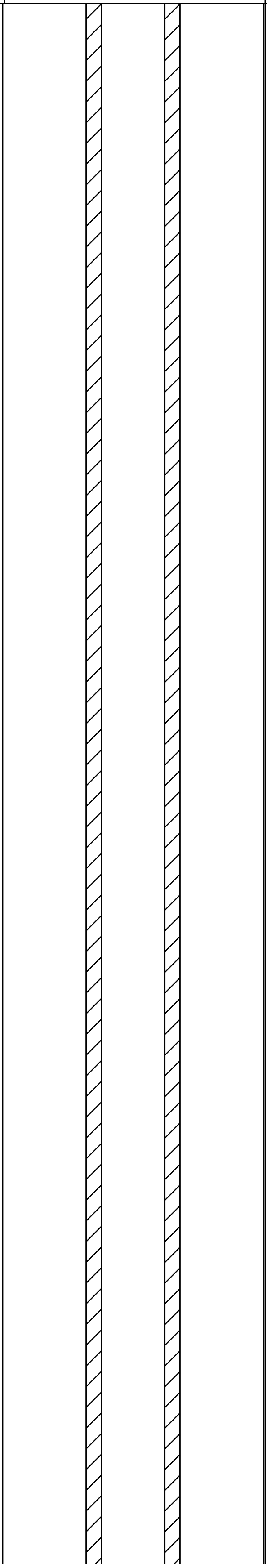
DEPTH FEET	BLOWN YIELD (GPM)	VOC (ppm)	LITHOLOGY	DEPTH FEET	WELL CONSTRUCTION DETAILS
90				90	
	<0.25 gpm	0			
100			GNEISS: fractures/iron staining @ 112', 115'-124', 127'-129', 132'-133'	100	9" dia. air rotary borehole, 35' - 320'
110				110	
120	~0.5 gpm	0		120	
130				130	Bentonite slurry 9"x6" annular seal, 35' - 318'
140			GNEISS: fractures/iron staining @ 142-144', 148-149'	140	
	2-3 gpm	0			
150				150	
160			GNEISS: fractures/iron staining @ 162'-164'	160	6" dia. steel casing with drive shoe and centralizers, 1' - 320'
			GNEISS		
170	3-4 gpm	0		170	
			GNEISS		
180				180	
			GNEISS: fractures/iron staining @ 186'-187'		

WELL CONSTRUCTION



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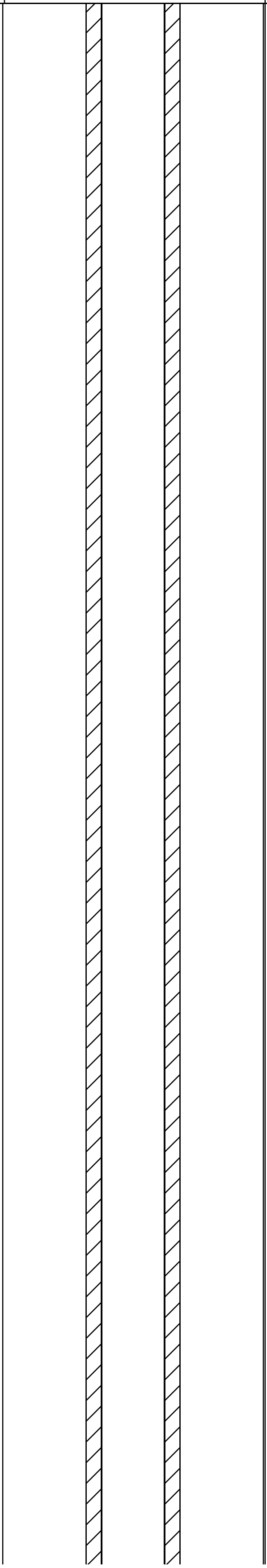
GROUNDWATER SCIENCES CORPORATION

GEOLOGIC LOG: SRMW-18RF

DEPTH FEET	BLOWN YIELD (GPM)	VOC (ppm)	LITHOLOGY	WELL CONSTRUCTION DETAILS
190				
	~4 gpm	0	GNEISS: fractures @ 207'-209', 214'-216'	
200				9" dia. air rotary borehole, 35' - 320'
210				
220	6-7 gpm	0		
230				Bentonite slurry 9"x6" annular seal, 35' - 318'
240				
	6-7 gpm	0	GNEISS	
250				
260				6" dia. steel casing with drive shoe and centralizers, 1' - 320'
			GNEISS	
270	6-7 gpm	0		
			GNEISS: possible small fracture @ 315'	
280				
290				



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GEOLOGIC LOG: **SRMW-18RF**

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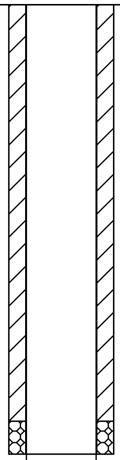

DEPTH FEET	BLOWN YIELD (GPM)	VOC (ppm)	LITHOLOGY	GRAPHIC	DEPTH FEET	WELL CONSTRUCTION	WELL CONSTRUCTION DETAILS
	6-7 gpm	0					
300					300		Bentonite slurry 9"x6" annular seal, 35' - 318'
310					310		6" dia. steel casing with drive shoe and centralizers, 1' - 320'
	6-7 gpm	0					
320	6-7 gpm	0	GNEISS: soft zone @ 320'		320		Bentonite chip 9"x6" annular seal, 318' - 320'
330					330		
340					340		
	0 gpm	0	GNEISS: soft zone @ 355', 360'				
350					350		6" dia. air rotary borehole, 320' - 500'
360	> 0.1 gpm	0			360		
370	0.1 - 0.25 gpm	0	GNEISS		370		
380					380		
390					390		
	0.25 gpm	0	GNEISS: soft zone @ 402'-403'				

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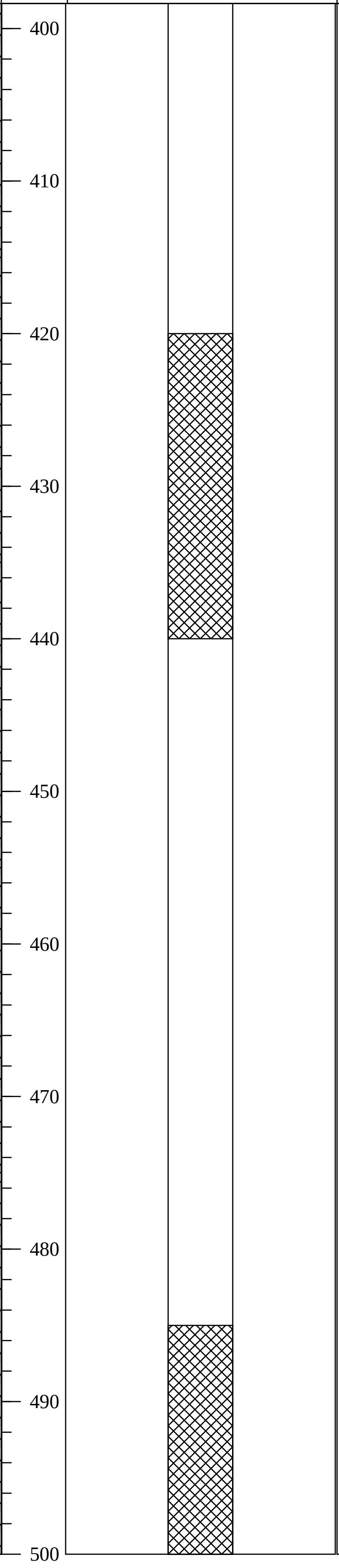
GROUNDWATER SCIENCES CORPORATION

GEOLOGIC LOG: SRMW-18RF

DEPTH FEET	BLOWN YIELD (GPM)	VOC (ppm)	LITHOLOGY	WELL CONSTRUCTION DETAILS
400	0.25 gpm	0		
				6" dia. air rotary borehole, 320' - 500'
410				
	1-2 gpm	0	GNEISS: large fracture @ 429'-431'	
420				FLUTe Sample Port #420 sampling interval 420' - 440'
430				
	6-8 gpm	0	GNEISS: possible fracture @ 455', 458'	
440	6-8 gpm	0		
450				
	6-8 gpm	0	GNEISS	
460				
470				
	8-10 gpm	0	GNEISS: possible fracture @ 492'	
480	8-10 gpm	0		
				FLUTe Sample Port #485 sampling interval 485' - 500'
490				
	~ 10 gpm	0		
500	~ 10 gpm	0		

WELL CONSTRUCTION



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GROUNDWATER SCIENCES CORPORATION

GEOLOGIC LOG: SRMW-19R

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PROJECT INFORMATION		DRILLING INFORMATION	
PROJECT:	***Shenandoah Road RI***	DRILLING CO.:	***Eichelbergers, Inc.***
SITE LOCATION:	***Town of East Fishkill, Dutchess Co., NY***	DRILLER:	***C. Knaub***
JOB NO.:	***01003.11.0105***	RIG TYPE:	***IR T4***
LOGGED BY:	***B. Titone/ E. Stoner***	DRILLING METHOD:	***Air Rotary***
		DEVELOPMENT DATE:	***2/22/07***
DATES DRILLED:	***8/17/06 - 8/25/06***	LOCATION:	***Seymore Lane cul-de-sac***

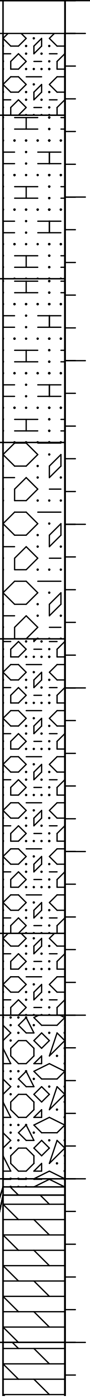
NOTES: SWL: 0.16' TOC, 4/25/07
TOC elevation: 322.29 ft amsl
Well reconstructed as a 2-inch PVC well

SURFACE ELEVATION: 322.69

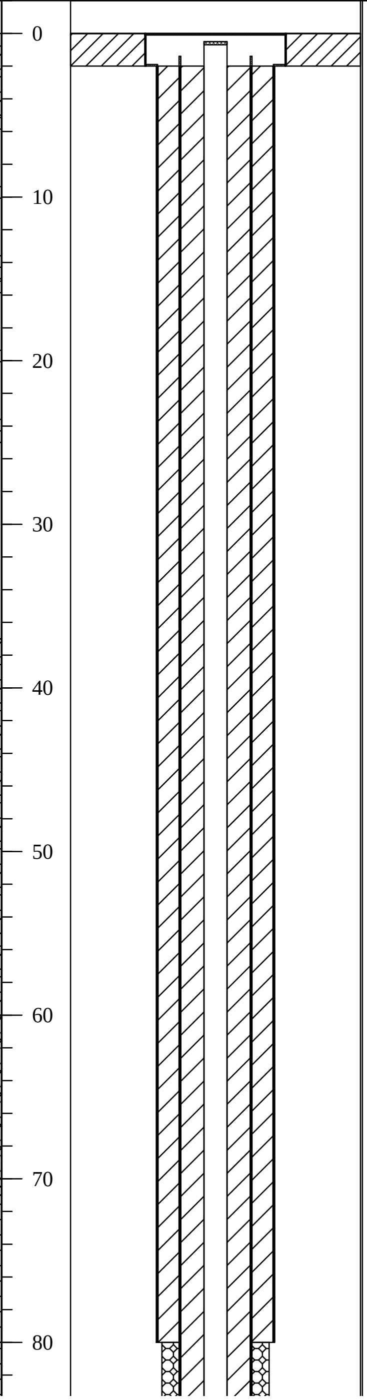
NORTHING: 981585.06 EASTING: 687415.43

DEPTH FEET	CUM. BLOWN YIELD	VOC (ppm)	LITHOLOGY
0			SILT, SAND & GRAVEL: dk yell. brown (10YR 4/2) f-sand f-m sub-ang gravel, damp cohesive
			CLAY & SILT: light olive gray (5Y 5/2) with minor f-sub-ang to sub-r gravel and m-c sand, moist and cohesive.
10			
			CLAY & SILT: olive gray (5Y 4/1) more clay than above, cohesive
20			
			SILT & GRAVEL: poorly sorted, various lithologies, granules to very coarse, ang-sub-ang, occasional subr, finer zone @ 28'-29'(predominantly granules)
30			
			SILT, SAND & GRAVEL: light olive gray (5Y 6/1), angular gravel some sub-ang with zones of subr, various lithologies, granules to c, trace vcgravel, very hard to drill - 16 min/foot
40			
50			
			SILT, SAND & GRAVEL: as above, predominantly dolostone and various subr gravel
60			GRAVEL: predominantly dolostone with trace rounded gravel, less sand and silt
70			GRAVEL: medium dark gray (N4), gravelly dolostone, some subr gravel
			DOLOSTONE: medium dark gray, weathered
			DOLOSTONE: pale olive (10Y 6/2)
80			DOLOSTONE: medium gray (N5)

GRAPHIC



DEPTH FEET — WELL CONSTRUCTION



WELL CONSTRUCTION DETAILS

12" flushmount manhole with 2" locking well cap

10" dia steel casing with STRADEX drive shoe, 1' to 80'

Bentonite slurry 10"x6" annular seal, 1' to 80'

6" dia steel casing w/ drive shoe, 1' to 86'

Bentonite slurry 6"x2" annular seal, 1' to 148.5'

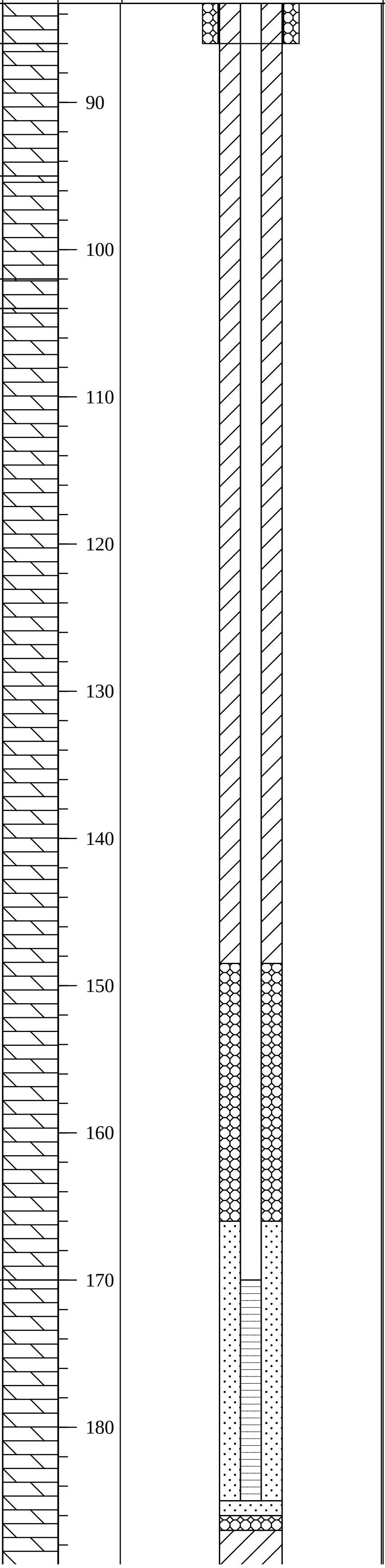
2" Dia. Sch. 40 PVC well riser, 0.5' to 170'

9.25" dia. air rotary borehole, 80' to 86'

Bentonite chip 9.25"x6" annular seal, 80' to 86'

DEPTH FEET	BLOWN YIELD (GPM)	VOC (ppm)	LITHOLOGY
			DOLOSTONE: medium light gray (N6)
90			
	0 gpm	0	DOLOSTONE: medium dark gray (N4)
100			
			DOLOSTONE: yellowish gray (5Y 8/1)
			DOLOSTONE: medium dark gray, pyrite from 120'-170', possible WBZ @ 119'-120'
110			
120	0 gpm	0	
130			
140			
	0.25 gpm	0	
150			
160			
170	0.25 gpm	0	DOLOSTONE: medium dark gray to medium gray, trace quartz, trace translucent to white calcite, FRACTURE @ 175'
180			

GRAPHIC — DEPTH FEET — WELL CONSTRUCTION



WELL CONSTRUCTION DETAILS

6" dia. air rotary borehole, 86' to 504.7'

Bentonite slurry 6"x2" annular seal, 1' to 148.5'

2" Dia. Sch. 40 PVC well riser, 0.5' to 170'

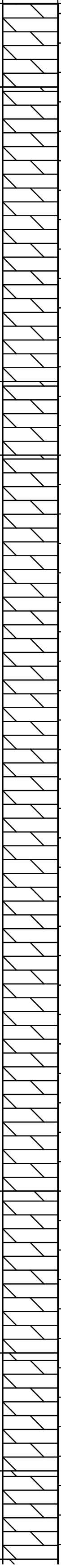
Bentonite chip 6"x2" annular seal, 148.5' to 166'

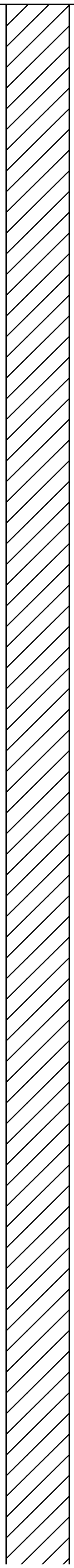
#2 grade sand pack 166' to 186'

2" Dia. PVC 10-slot screen, 170' to 185'

Bentonite chip backfill seal, 186' to 187'

DEPTH FEET	BLOWN YIELD (GPM)	VOC (ppm)	LITHOLOGY	GRAPHIC	DEPTH FEET	WELL CONSTRUCTION	WELL CONSTRUCTION DETAILS
190					190		
	4 gpm	0	DOLOSTONE: medium dark gray, trace clear to white (N9) dolostone				
200					200		6" dia. air rotary borehole, 86' to 504.7'
210					210		
			DOLOSTONE: medium dark gray, trace shaley dolostone, trace macrocrystalline pyrite				
220	4 gpm	0	DOLOSTONE: medium dark gray		220		
230					230		
240					240		
	4 gpm	0					
250					250		Bentonite slurry backfill seal, 187' to 504.7'
260					260		
270	4 gpm	0	DOLOSTONE: medium dark gray, trace shaley dolostone		270		
280					280		
			DOLOSTONE: medium light gray, light gray and translucent				
290			DOLOSTONE: medium dark gray, trace shaley dolostone		290		





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GROUNDWATER SCIENCES CORPORATION

GEOLOGIC LOG: SRMW-19R

DEPTH FEET	BLOWN YIELD (GPM)	VOC (ppm)	LITHOLOGY	GRAPHIC	DEPTH FEET	WELL CONSTRUCTION	WELL CONSTRUCTION DETAILS
	4 gpm	0	DOLOSTONE: medium dark gray				
300					300		
			DOLOSTONE: medium gray and brownish gray (5YR 4/1)				
310					310		6" dia. air rotary borehole, 86' to 504.7'
320	4 gpm	0	DOLOSTONE: medium gray and brownish gray, some sei-translucent speckeled brownish gray dolostone at bottom		320		
330					330		
340					340		
	4 gpm	0					
			DOLOSTONE: dark gray (N3), trace phyllitic foliations, some pyrite				
350					350		Bentonite slurry backfill seal, 187' to 504.7'
360			DOLOSTONE: dark gray, some shaley layers, trace pyrite/chalcopyrite, pea sze pyrite at 379'		360		
370	4 gpm	0			370		
380			DOLOSTONE: medium dark gray, spotted/speckled		380		
390			DOLOSTONE: dark to medium dark gray, pyrite present, sometimes large		390		
	4 gpm	0					
400					400		

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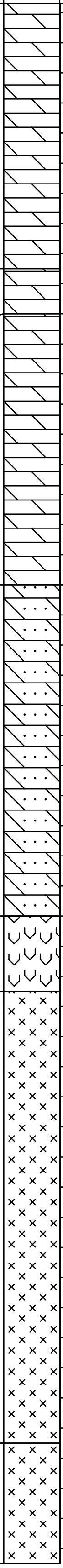
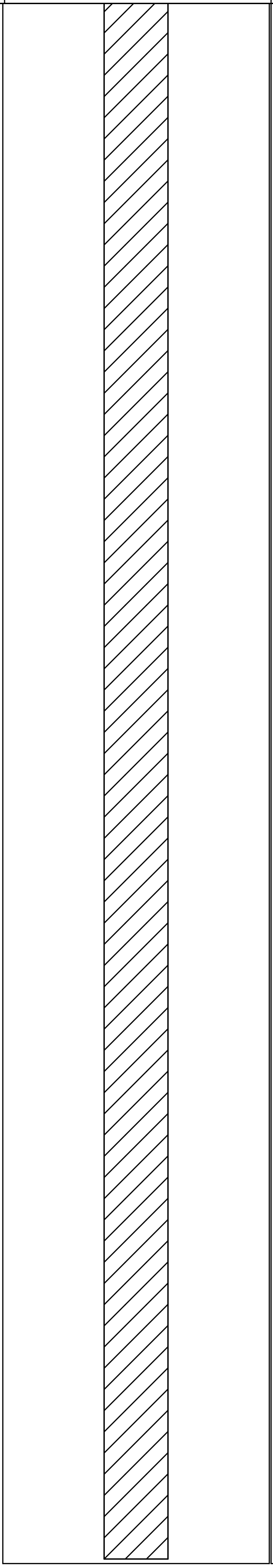
DEPTH FEET	BLOWN YIELD (GPM)	VOC (ppm)	LITHOLOGY	WELL CONSTRUCTION DETAILS
410				
	4 gpm	0		
420			DOLOSTONE: varied colors, thinly layered, slightly translucent, speckled/shiny, trace pyrite	6" dia. air rotary borehole, 86' to 504.7'
			DOLOSTONE: trace pyrite, semi-translucent, some lighter/darker zones	
430				
	4 gpm	0		
440			SANDY DOLOSTONE: brownish black (5YR 2/1), grading to more greenish color at bottom	
450				Bentonite slurry backfill seal, 187' to 504.7'
	4 gpm	0		
460				
			QUARTZ: milky to smoky, sightly translucent, trace pyrite	
			QUARTZITE: dusky yellow green (10GY 3/2) with some lighter/darker zones	
470				
	4 gpm	0		
480				
490				
	4 gpm	0		
			QUARTZITE: dusky yellow green with some lighter/darker zones	
500				
		0		





GROUNDWATER SCIENCES CORPORATION

GEOLOGIC LOG: SRMW-19S

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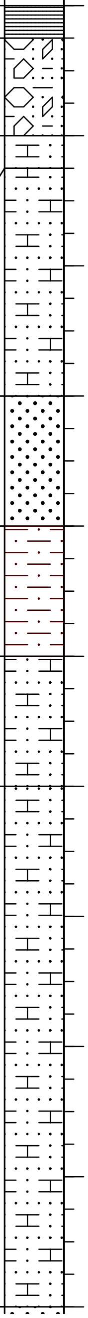
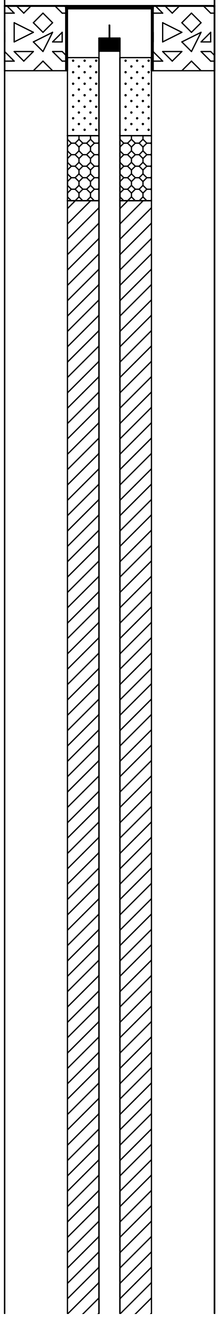
PROJECT INFORMATION		DRILLING INFORMATION	
PROJECT:	*Shenandoah Road RI*	DRILLING CO.:	*Parratt-Wolff Inc.*
SITE LOCATION:	*Town of East Fishkill, Dutchess Co., NY*	DRILLER:	*Ian Grassie/Jolaan Price*
JOB NO.:	*01003.11.0105*	RIG TYPE:	*CME 45*
LOGGED BY:	*Ed Stoner*	DRILLING METHOD:	*Hollow Stem Auger*
DATE DRILLED:	*10/10/2006 - 10/12/2006*	DEVELOPMENT DATE:	*4/11/07*
		LOCATION:	*Seymour Lane cul-de-sac*

NOTES: SWL: 0.80' below TOC, 10/13/06, 12:45
TOC elevation: 322.69 ft amsl

SURFACE ELEV. 322.69
EASTING 687412.0
NORTHING 981595.0

DEPTH FEET	BLOW COUNTS	VOC (ppm)	RECOV.	SAMP. #	SOIL DESCRIPTION	DEPTH FEET	WELL CONSTRUCTION DETAILS
0	-- 7 10 9	0	15"	1	ASPHALT: pavement SILT, SAND & GRAVEL: dark yellowish brown (10 YR 4/2), fine to very coarse, silty, with gravel, moist	0	9" Morrison manhole, 2" plug and lock
2	8 10 10 7	0	18"	2	CLAY & SILT: dark yellowish brown, trace of fine to medium sand, moist CLAY & SILT: medium gray (N5) to dark greenish gray (5 GY 4/1), trace of fine sand, trace of organics, moist, saturated at 6 feet	2	Bentonite chip annular seal (2'-3')
4	8 9 8 7	0	16"	3		4	8" dia. HSA borehole (0'-40.5')
6	7 6 7 10	0	12"	4	SAND: dark yellowish brown, very fine to fine, trace of silt, trace of gravel, moist	6	
8	5 13 13 10	0	15"	5	SILT: dark yellowish brown, predominantly silt, trace of clay and fine sand, moist	8	
10	11 10 13 14	0	18"	6	CLAY & SILT: medium gray, wet	10	Bentonite slurry annular seal (3'-22')
12	13 14 17 17	0	22"	7	CLAY & SILT: medium gray, wet	12	
14	4 7 10 9	0	23"	8		14	2" dia. sch 40 PVC riser (0.5'-25')
16	11 10 10 9	0	24"	9		16	
18	4 6 8 8	0	24"	10		18	
20						20	





GROUNDWATER SCIENCES CORPORATION

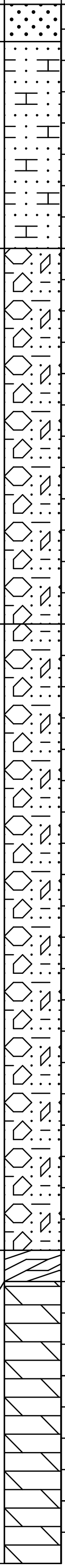
GEOLOGIC LOG: SRMW-19S

Page 2 of 2

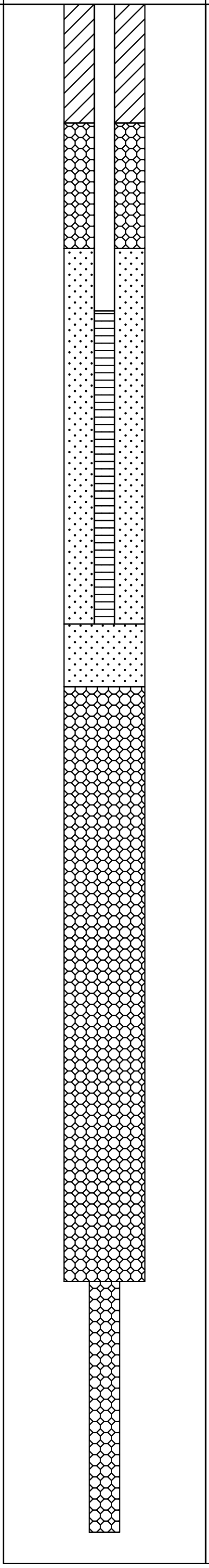
PROJECT: *Shenandoah Road RI*

DEPTH FEET	BLOW COUNTS	VOC (ppm)	RECOV.	SAMP. #	SOIL DESCRIPTION
	WOH 3 4 8	0	18"	11	SAND CLAY & SILT: medium gray, wet
22	3 9 9 14	0	19"	12	
24	29 41 44 34	0	18"	13	SILT, SAND & GRAVEL: silty, SA-SR gravel of various lithologies, medium dense, saturated
26	17 41 50.0.4' augered	0	12"	14	
28	34 39 50/0.1' augered	0	8"	15	
30	39 50/0.4'	0	6"	16	SILT, SAND & GRAVEL: with poorly sorted sand and silt, very dense, cobbles and boulders present, moist
	augered	---	---	---	
32	39 50/0.4'	0	3"	17	
	augered	---	---	---	
34	49 50/0.1'	0	7"	18	
	augered	---	---	---	
36	50/0.2'	0	2"	19	
	augered to 38 ft	---	---	---	
38	50/0.3'	0	0"	20	
	augered	---	---	---	
40	39 50/0.2'	0	5"	21	WEATHERED DOLOSTONE: soft, broken
42 44	HQ core	---	4.0'/ 4.0'	RUN 1	DOLOSTONE: abundant, nearly vertical sealed fractures, high angle bedding, 1" shalely layer at 43.5 feet

GRAPHIC



WELL CONSTRUCTION



WELL CONSTRUCTION DETAILS

Bentonite slurry annular seal (3'-22')

2" dia. sch 40 PVC riser (0.5'-25')

Bentonite chip annular seal (22'-24')

#00 Sand pack (24'-31')

2" dia. 10-slot PVC screen (25'-30')

8" dia. HSA borehole (0'-40.5')

Bentonite chip backfill (31'-44.5')

HQ core borehole (40.5' - 44.5')

Final 9/19/07

GROUNDWATER SCIENCES CORPORATION

GEOLOGIC LOG: SRMW-20R

Page 1 of 4

PROJECT INFORMATION		DRILLING INFORMATION	
PROJECT:	*Shenandoah Road RI*	DRILLING CO.:	*Eichelbergers, Inc.*
SITE LOCATION:	*Town of East Fishkill, Dutchess Co., NY*	DRILLER:	*C. Knaub*
JOB NO.:	*01003.11.0105*	RIG TYPE:	*IR T4*
LOGGED BY:	*B. Titone*	DRILLING METHOD:	*Air Rotary*
		DEVELOPMENT DATE:	*4/18/07*
DATES DRILLED:	*9/6/06 - 9/11/06*	LOCATION:	*Weitz Road immediately south of Shenandoah Road*

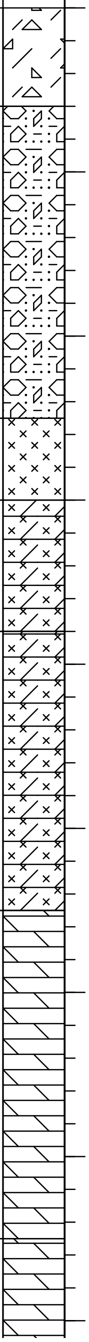
NOTES: Artesian, flowing around 20 GPM (5 psi on well seal) 9/11/06
TOC elevation: 345.51 ft amsl

SURFACE ELEVATION: 341.96 ft amsl

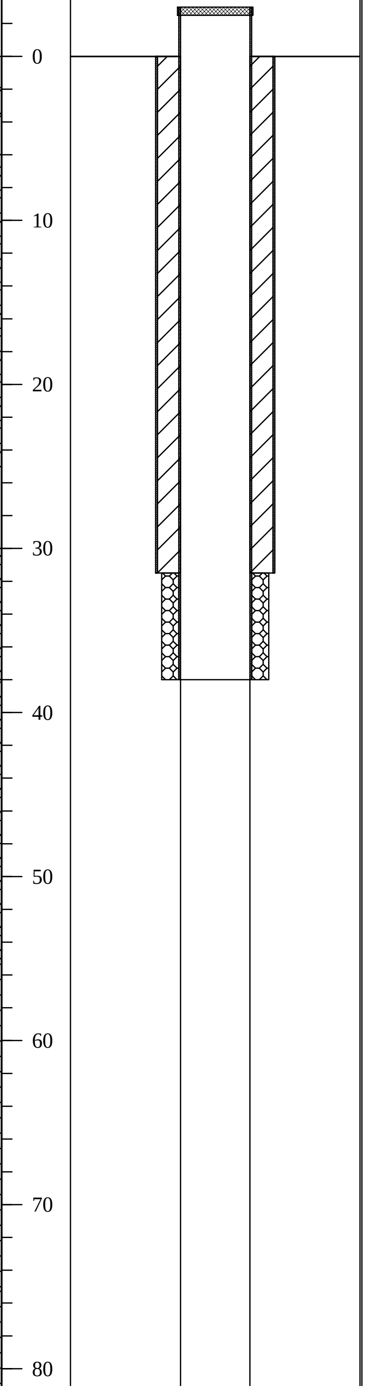
NORTHING: 979926.18 EASTING: 686349.50

DEPTH FEET	CUM. BLOWN YIELD	VOC (ppm)	LITHOLOGY	WELL CONSTRUCTION DETAILS
0			FILL SILT, SAND & GRAVEL: gravel consists of gneiss, quatzite and sandstone	6" locking well cap 10" dia steel casing with STRADEX drive shoe, 0' to 31'
10				Bentonite slurry 9.25"x6" annular seal, 0' to 31'
20			QUARTZITE: medium gray (N5) slightly weathered	6" dia. steel casing with drive shoe and centralizers, +3' to 37.5'
30			DOLOMITIC QUARTZITE: medium gray (N5) DOLOMITIC QUARTZITE: olive gray, trace pyrite/chalcopyrite, some layering, some phyllitic payers on bedding surfaces	9.25" dia. air rotary borehole, 30' to 37.5' Bentonite chip 9.25"x6" annular seal, 31' to 37.5'
40	0 gpm	0		
50			DOLOSTONE: sligtly quartzitic, (N4) some thin phyllitic payers	
60				6" dia. air rotary borehole, 37.5' to 320'
70	0 gpm 0 gpm	0	DOLOSTONE: olive gray with some lighter zones, slightly layered	
80				

GRAPHIC



DEPTH FEET — WELL CONSTRUCTION



Final 9/19/07

GROUNDWATER SCIENCES CORPORATION

GEOLOGIC LOG: **SRMW-20R**

DEPTH FEET	BLOWN YIELD (GPM)	VOC (ppm)	LITHOLOGY	GRAPHIC	DEPTH FEET	WELL CONSTRUCTION	WELL CONSTRUCTION DETAILS
90					90		
	0 gpm	0	QUARTZITE: light olive gray to slightly translucent, dark specks, trace pyrite, occasional olive gray bedding surfaces slateylayer with pyrite (N2) at 117', FRACTURES@ 105'-107' and 110'				
100					100		6" dia. air rotary borehole, 37.5' to 320'
110					110		
120	6 gpm	0	QUARTZITE: light gray, some slatey layers, sugary slightly resinous with black specks		120		
			QUARTZITE: olive gray (5Y 4/1) resinous, sugary, some semi-translucent, dark specks				
130					130		
140			QUARTZITE: dusky yellow gray with lighter shades, slightly translucent. sugary, resinous		140		
	6 gpm	0					
150			QUARTZITE: with quartz, milky to rosy (grayish pink to medium red brown) trace feldspar		150		
			GNEISS: greenish black, slightly foliated with milky quartz blebs/bands common, trace pyrite, slightly schistose, fine grained				
160					160		
170	9 gpm	0			170		
180					180		
			GNEISS: greenish black, trace pyrite, some foliation,				

DEPTH FEET	BLOWN YIELD (GPM)	VOC (ppm)	LITHOLOGY	WELL CONSTRUCTION DETAILS
			light colored blebs, quartz zones/layers interspersed, trace feldspar,fine grained	
190				
	9 gpm	0		
200				6" dia. air rotary borehole, 37.5' to 320'
			QUARTZ: milky quartz	
			GNEISS: greenish black with abundant milky quartz, trace pyrite, fine grained	
210				
220	11 gpm	0	QUARTZ: milky quartz	
			GNEISS: greenish black, some fine banding/foliation, slightly schistose with some biotite, trace pyrite, some milky quartz,some dark specks, fine grained	
230				
240				
	25 gpm	0		
250				
260				
			GNEISS: greenish black to greenish gray, f-m grained with lighter quartz rich zones, pyrite common/fine, slight foliation,trace pink feldspar, FRACTURE @ 282'	
270	25 gpm	0		
280				
			GNEISS: greenish black to olive gray with zones of ligher green to light gray, slight foliation, trace pyrite/biotite, somestronger foliations toward bottom or interval, FRACTURE @ 291'	
290				

DEPTH FEET	BLOWN YIELD (GPM)	VOC (ppm)	LITHOLOGY	GRAPHIC	DEPTH FEET	WELL CONSTRUCTION	WELL CONSTRUCTION DETAILS
	>50 gpm	0					
300			GNEISS: greenish black to dark olive green, slight shistosity, pyrite/feldspar common, m-f grained, trace biotite, trace rosyquartz		300		6" dia. air rotary borehole, 37.5' to 320'
310					310		
320	>50 gpm	0			320		

Final 5/13/12

GROUNDWATER SCIENCES CORPORATION

GEOLOGIC LOG: SRMW-20RA

PROJECT INFORMATION

PROJECT: ***Shenandoah Road RI***
SITE LOCATION: ***Town of East Fishkill, Dutchess Co., NY***
JOB NO.: ***01003.11.0105***
LOGGED BY: ***E. Stoner***
DATES DRILLED: ***10/31/06 - 11/03/06***

DRILLING INFORMATION

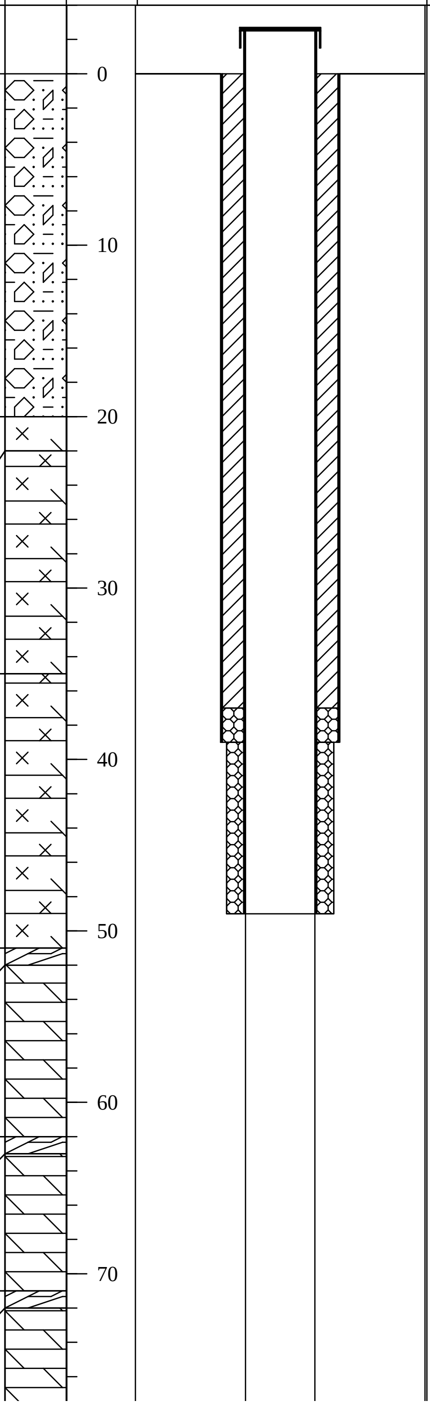
DRILLING CO.: ***Eichelbergers, Inc.***
DRILLER: ***C. Knaub***
RIG TYPE: ***IR T4W***
DRILLING METHOD: ***Air rotary***
DEVELOPMENT DATE: ***4/18/07***
LOCATION: ***W. side of Weitz Road, immediately S. of Shenandoah Road***

NOTES: Artesian flow measured at 0.2 GPM
Top of casing elevation: 345.33 ft amsl

SURFACE ELEVATION: 342.11 ft amsl
NORTHING: 979927.10 EASTING: 686340.95

DEPTH FEET	CUM. BLOWN YIELD	VOC (ppm)	LITHOLOGY
0			SILT, SAND & GRAVEL: boulders and cobbles at 15 feet
10			
20			DOLOMITIC QUARTZITE: medium gray (N5) fractured, weathered
			DOLOMITIC QUARTZITE: medium gray, fractures at 28', 30', 32', and 35'
30			
	5 gpm	0	DOLOMITIC QUARTZITE: medium gray, trace of pyrite, some phyllitic layers
40			
50			FRACTURED DOLOSTONE: soft zone
			DOLOSTONE: medium gray and brownish gray (5 YR 4/1) to olive gray (5 Y 4/1) trace of pyrite, occ. phyllitic layers
60			
			FRACTURED DOLOSTONE: soft zone
			DOLOSTONE: medium gray and brownish gray (5 YR 4/1) to olive gray (5 Y 4/1) trace of pyrite, occ. phyllitic layers
	0 gpm	0	
70			
			FRACTURED DOLOSTONE: soft zone
			DOLOSTONE: medium gray and brownish gray (5 YR 4/1) to olive gray (5 Y 4/1) trace of pyrite, occ. phyllitic layers

GRAPHIC | DEPTH FEET | WELL CONSTRUCTION



WELL CONSTRUCTION DETAILS

6" sealing/locking well cap

10" dia. steel casing with STRADEX drive shoe, 0' to 39'

Bentonite slurry 10"x6" annular seal, 0' to 37'

6" dia. steel casing with drive shoe, +2.5' to 49'

9.25" dia. air rotary borehole, 39' to 49'

Bentonite chip annular seal, 37' to 49'

6" dia. air rotary borehole, 49' to 268'

Final 5/13/12

GROUNDWATER SCIENCES CORPORATION

GEOLOGIC LOG: SRMW-20RA

DEPTH FEET	BLOWN YIELD (GPM)	VOC (ppm)	LITHOLOGY	DEPTH FEET	WELL CONSTRUCTION	WELL CONSTRUCTION DETAILS
80			QUARTZITE: dolomitic	80		
			QUARTZITE: light gray (N7) to translucent, trace of pyrite			
90				90		
	Trace	0				
			QUARTZITE: light gray with dark specks, occasional dark gray (N3) layers			
100				100		6" dia. air rotary borehole, 49' to 268'
110				110		
			FRACTURED QUARTZITE: soft zone			
			QUARTZITE: dark greenish gray (5 G 4/1)			
120	0.5 gpm	0		120		
130				130		
			GNEISS: greenish black (5 GY 2/1) slightly schistose texture, occasional pyrite, little white to translucent quartz			
140				140		
150	1.5 gpm	0		150		
160				160		
170	1.5 gpm	0		170		

Final 5/13/12

DEPTH FEET	BLOWN YIELD (GPM)	VOC (ppm)	LITHOLOGY	GRAPHIC	DEPTH FEET	WELL CONSTRUCTION	WELL CONSTRUCTION DETAILS
180			GNEISS: greenish black, increased quartz content, occasional milky quartz layers		180		
190					190		
	1.5 gpm	0					
200					200		6" dia. air rotary borehole, 49' to 268'
210					210		
	20 gpm	0					
220					220		
230					230		
240					240		
	20 gpm	0					
250					250		
260					260		
	20 gpm	0					
270					270		

A-1c: SRMW- Locations USGS Geophysical Logs

BOREHOLE GEOPHYSICAL LOG

English/Metric units E

SiteID (C1) 413138073473801	**Station name (C12)** Du 3225	**Other ID** SRMW-1RB		**Log date** 1/10/2006
County Dutchess	**State** New York	**Project** 2457-CCW00	**Recorded by** JAA	**Observed by** RJR
Location description			**Owner** Ground Water Science	
Latitude 41 31 38.4	**Longitude** 073 47 38.2	**Lat/Long datum** NAD83	**Log measurement point (LMP)** LS	
Height LMP 0	**Altitude LMP** 482.57	**Altitude datum** NGVD88	**Description of LMP** Land surface	
Borehole depth 400	**Borehole diameter** 6	**Casing bottom** 28.5	**Casing diameter** 6	**Casing type** steel
Source of data USGS	**Logging unit** Troy, New York	**Log orientiation** TN	**Magnetic declination** -13.5	
Software non-ASCII logs	**Fluid type** Water	**Fluid depth below LMP** 5.85	**at time** 17:45	
Hydrologic conditions Ambient, pump 0.74 gal/min for 119 min, drawdown= 5.23ft		**Type of log** ZZ		

Tool manufacturer and model, tool serial number, log date and time, logging direction and speed, depth error after logging, log parameter(s) and date(s) of calibration check

Tool run 1 Mount Sopris 2SFB, 3009, 1/9/2006 12:41, log down 20 ft/min, depth error= 1.36ft, amb fluid temp and cond - cal check 1/5/2006.

Tool run 2 Mount Sopris 2PGA, 3009, 1/9/2006 13:10, log up 20ft/min, depth error= 1.36, caliper - cal check 1/5/2006

Tool run 3 Century 9620, 1046, 1/9/2006 0953, log up 20 ft/min, depth error= 0.08, magnetic suscept-gamma-deviation - dev tilt test at surface, mag suscept 7/5/2005

Tool run 4 Century 9510, 746,07:44, log up 20 ft/min, depth error= -1.22, conductivity/resisvity and gamma

Tool run 5 Mount Sopris - 00630, 09:45, log up 3 ft/min,depth error= 0.07ft, optical image and deviation- tilt test at surface

Tool run 6 Mount Sopris - 020906, 14:37, log up 4 ft/min,depth error= 0.837ft, acoustic image and deviation- tilt test at surface

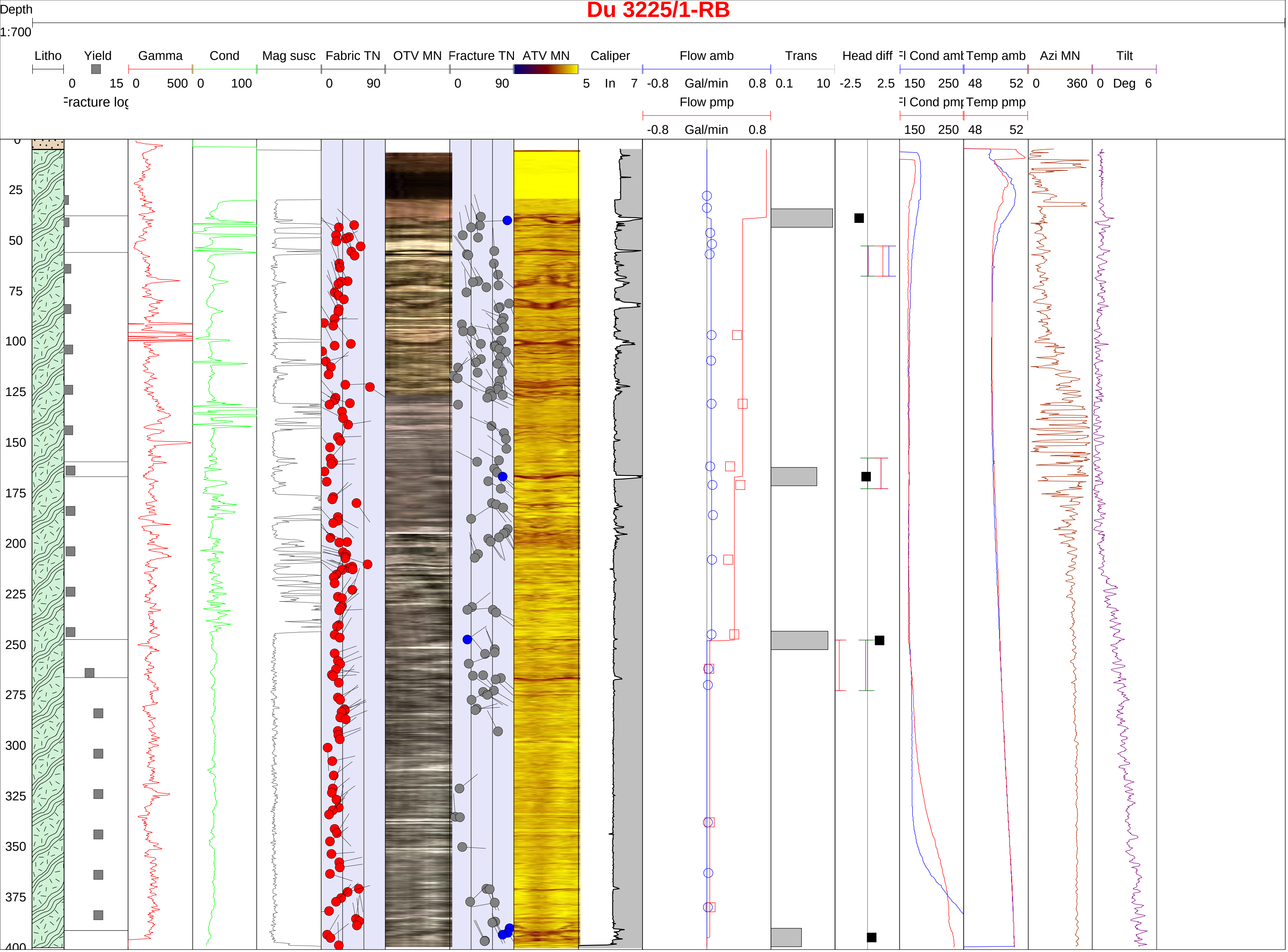
Tool run 7 Mount Sopris - HPFM, HFP2060, 14:56, log down stationary measurments, ambient heat pulse flowmeter

Tool run 8 Mount Sopris - HPFM, HFP2060, 18:10, log up stationary measurments, depth correction= -0.07ft, pumping heat pulse flowmeter - in hole cal check.

Tool run 9 Mount Sopris 2SFB, 3009, 12:41, log down 20 ft/min, depth error= 0.0ft, pmp fluid temp and cond - cal check 1/5/2006.

Remarks stickup = 2.2ft ALS.

Du 3225/1-RB



Depth
1:700
Litho
Yield
0 15
Fracture log
Gamma
0 500
Cond
0 100
Mag susc
Fabric TN
0 90
OTV MN
Fracture TN
0 90
ATV MN
Caliper
5 In 7
Flow amb
-0.8 Gal/min 0.8
Flow pmp
-0.8 Gal/min 0.8
Trans
0.1 10
Head diff
-2.5 2.5
Fl Cond amb
150 250
Fl Cond pmp
150 250
Temp amb
48 52
Temp pmp
48 52
Azi MN
0 360
Tilt
0 Deg 6
0
25
50
75
100
125
150
175
200
225
250
275
300
325
350
375
400

BOREHOLE GEOPHYSICAL LOG

English/Metric units E

SiteID (C1) 413155073470401	**Station name (C12)** Du 3226	**Other ID** MW-2R	**Log date** 1/12/2006
County Dutchess	**State** New York	**Project** CCW00	**Recorded by** JAA
Observed by RJR			

County Dutchess | **State** New York | **Project** CCW00 | **Recorded by** JAA | **Observed by** RJR

Location description | **Owner** Ground Water Sciences

Latitude 41 31 55 | **Longitude** 073 47 04 | **Lat/Long datum** NAD83 | **Log measurement point (LMP)** LS

Height LMP 0.0 | **Altitude LMP** 358.29 | **Altitude datum** NGVD29 | **Description of LMP** Land surface

Borehole depth 500 | **Borehole diameter** 6 - 8 | **Casing bottom** 80 | **Casing diameter** 8 | **Casing type** steel

Source of data USGS | **Logging unit** Troy | **Log orientiation** MN | **Magnetic declination** -13.5

Software non-ASCII logs | **Fluid type** water | **Fluid depth below LMP** 44.05 | **at time** 16:14

Hydrologic conditions ambient, pump 2.4gal/min, start pump at 16:16 stop pump at 19:09, drawdown= 6.62ft | **Type of log** ZZ

Tool manufacturer and model, tool serial number, log date and time, logging direction and speed, depth error after logging, log parameter(s) and date(s) of calibration check

Tool run 1 Century 9065, 1/11/2006, log up 20ft/min, depth error= -1.52ft, well diameter - calibration check in hole

Tool run 2 Century 9042, 1/11/2006, log down 20 ft/min, depth error= 0.31 ft, gamma and ambient fluid temp and cond

Tool run 3 Century 9620, 1/11/2006, 1046, 1/9/2006 0953, log up 20 ft/min, depth error= 0.08, magnetic suscept-gamma-deviation - dev tilt test at surface, mag suscept 7/5/2005

Tool run 4 Century 9510, 1/11/2006, log up 20 ft/min, depth error= -1.07, conductivity/resisvity and gamma

Tool run 5 Mount Sopris -ABI-40, 1/11/2006, log up 4 ft/min, depth error= -1.1ft, optical image and deviation- in hole cal check

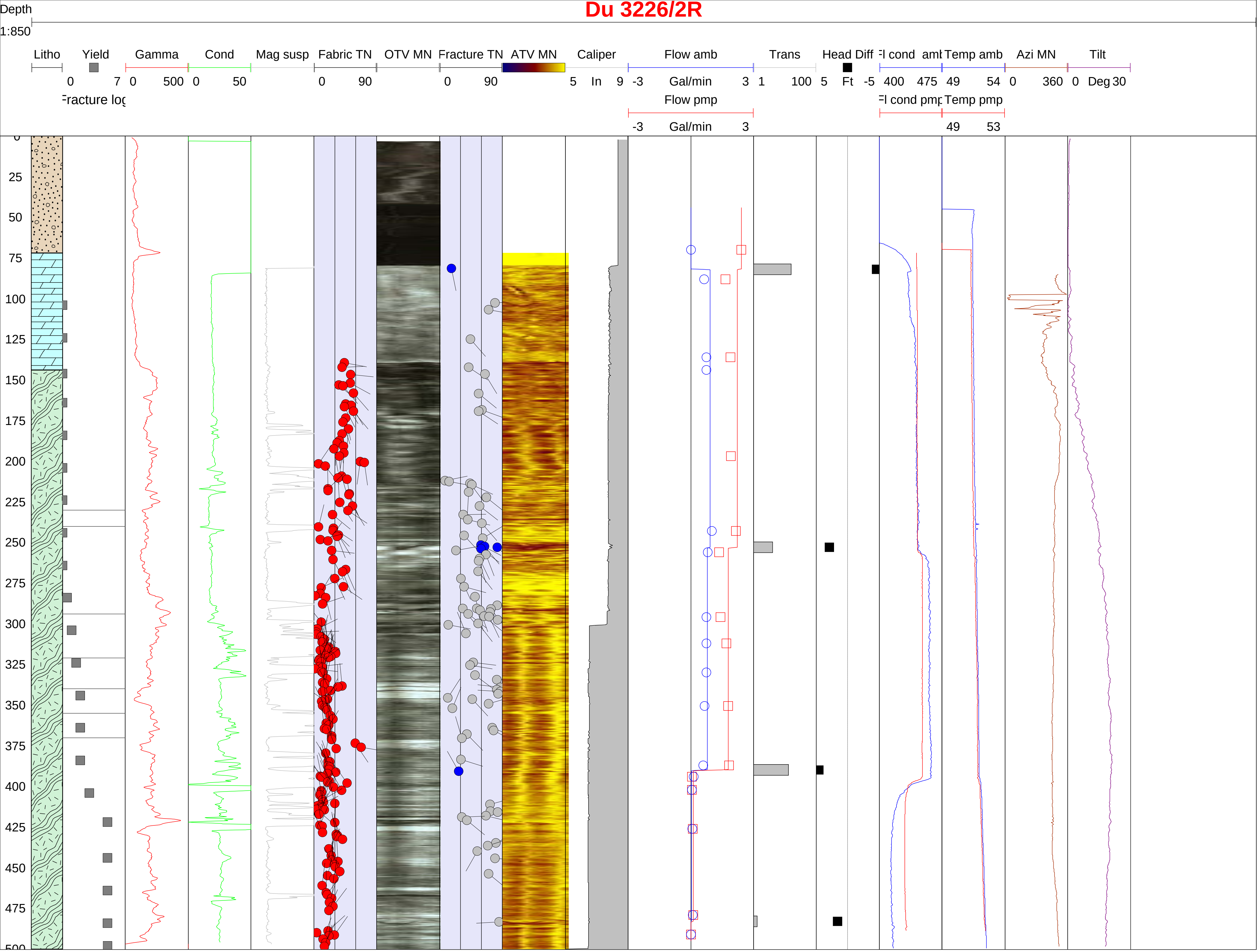
Tool run 6 Mount Sopris -OBI-40, 000603, 1/11/2006, log up 4 ft/min, depth error= 4.91ft, optical image and deviation- in hole cal check

Tool run 7 Mount Sopris - HPFM, HFP2060, 12:45, log up stationary measurments, ambient heat pulse flowmeter .

Tool run 8 Mount Sopris - HPFM, HFP2060, 17:04, log up stationary measurments, depth correction= 0.62ft, pumping heat pulse flowmeter - in hole cal check

Tool run 9 Century 9042, log down 20 ft/min, pumping fluid temp and cond

Remarks casing stickup=2.90ft ALS,


Du 3226/2R
Depth
1:850
Litho
Yield
0 7
Fracture log
Gamma
0 500
Cond
0 50
Mag susp
Fabric TN
0 90
OTV MN
Fracture TN
0 90
ATV MN
Caliper
5 In 9
Flow amb
-3 Gal/min 3
Flow pmp
-3 Gal/min 3
Trans
1 100
Head Diff
5 Ft -5
Fl cond amb
400 475
Fl cond pmp
Temp amb
49 54
Temp pmp
49 53
Azi MN
0 360
Tilt
0 Deg 30
0
25
50
75
100
125
150
175
200
225
250
275
300
325
350
375
400
425
450
475
500

BOREHOLE GEOPHYSICAL LOG

English/Metric units E

SiteID (C1) 413226073473501 | **Station name (C12)** Du 3244 | **Other ID** SRMW-4 | **Log date** 6/27/2007

County Dutchess | **State** New York | **Project** CCW00 | **Recorded by** JAA | **Observed by** RJR

Location description | **Owner** Ground Water Sciences

Latitude 41 32 26.0 | **Longitude** 073 47 35.6 | **Lat/Long datum** NAD83 | **Log measurement point (LMP)** LS

Height LMP 0.0 | **Altitude LMP** 277.99 | **Altitude datum** NGVD88 | **Description of LMP** Land surface

Borehole depth 502 | **Borehole diameter** 6 | **Casing bottom** 45 | **Casing diameter** 6 | **Casing type** steel

Source of data USGS | **Logging unit** Troy | **Log orientiation** MN | **Magnetic declination** -13.5

Software non-ASCII logs | **Fluid type** water | **Fluid depth below LMP** 4.31 **at time** 15:04

Hydrologic conditions ambient, pump 0.8gal/min, start pump at 13:12 stop pump at 15:01, drawdown= 3.88ft | **Type of log** ZZ

Tool manufacturer and model, tool serial number, log date and time, logging direction and speed, depth error after logging, log parameter(s) and date(s) of calibration check

Tool run 1 Century 9065, 574, 09:01, log up 25ft/min, depth error= 0.12ft, caliper cal check 10/21/2009.

Tool run 2 Century 9042-858, 09:20, log down 25 ft/min, depth error= 0.02 ft, gamma and ambient fluid temp and cond- fluid temp and cond in hole cal check.

Tool run 3 Century 9800-1106, 09:57, log up 10 ft/min, depth error= 0.35ft, acoustic image and deviation- in hole cal check.

Tool run 4 Mount Sopris -OBI-MK4, 073612, 11:00, log up 10 ft/min, depth error= 0.18ft, optical image and deviation- in hole cal check

Tool run 5 Mount Sopris - HPFM, HFP2060, 11:50, log down stationary measurments, ambient heat pulse flowmeter

Tool run 6 Mount Sopris - HPFM, HFP2060, 13:28, log up stationary measurments, depth correction= 0.25ft, pumping heat pulse flowmeter - in hole cal check.

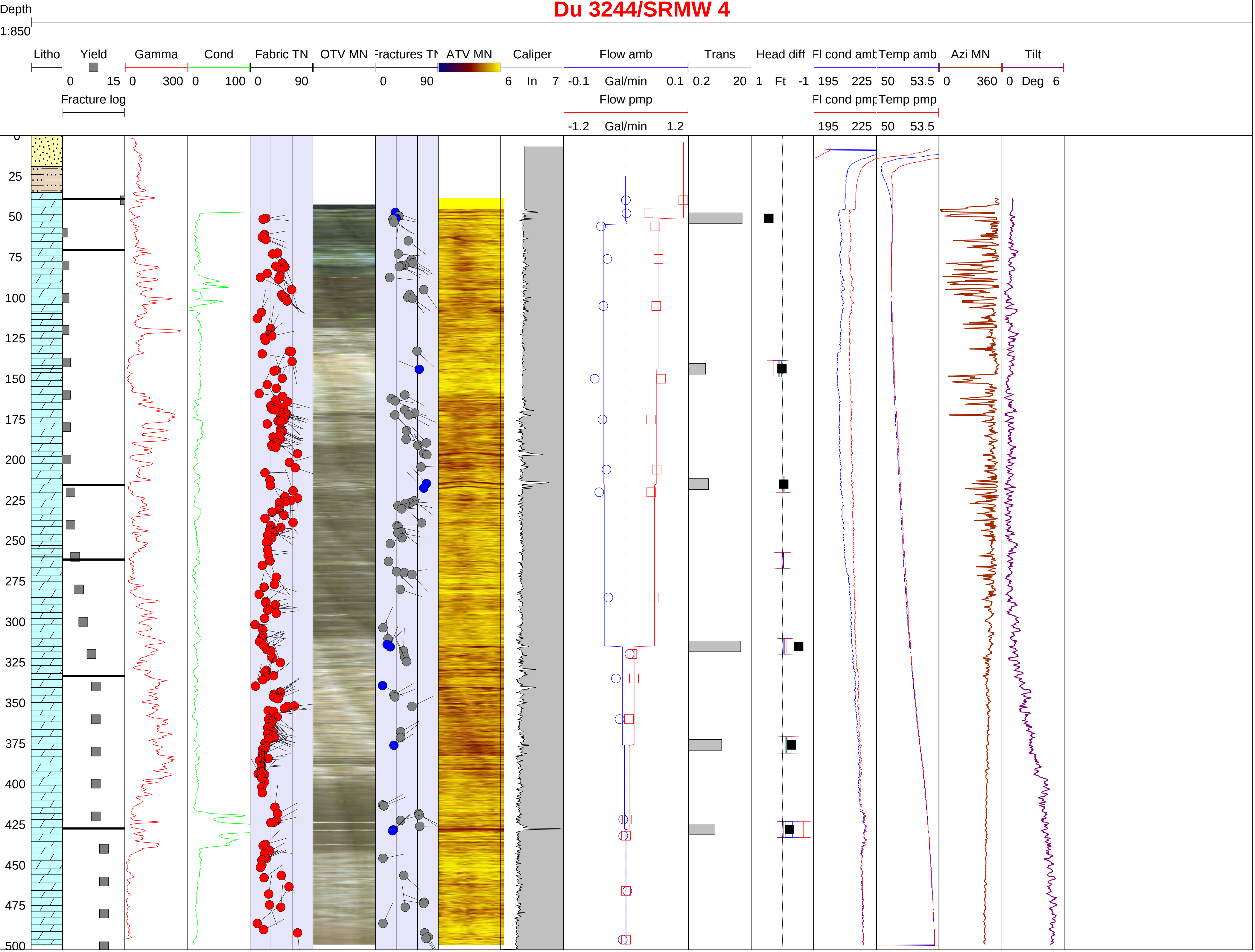
Tool run 7 Century 9042-858, 14:37, log down 20 ft/min, gamma and pumping fluid temp and cond

Tool run 8

Tool run 9

Remarks Casing stickup = 1.2ft above land surface.
A

Du 3244/SRMW 4



BOREHOLE GEOPHYSICAL LOG

English/Metric units E

SiteID (C1) 413206073471401
Station name (C12) Du 3241
Other ID SRMW-11
Log date 3/14/2007

County Dutchess
State New York
Project CCW00
Recorded by JAA
Observed by RJR

Location description
Owner Ground Water Sciences

Latitude 41 32 06.5
Longitude 073 47 14.7
Lat/Long datum NAD83
Log measurement point (LMP) LS

Height LMP 0.0
Altitude LMP 306.37
Altitude datum NGVD29
Description of LMP Land surface

Borehole depth 499.5
Borehole diameter 6
Casing bottom 54
Casing diameter 6
Casing type steel

Source of data USGS
Logging unit Troy
Log orientiation MN
Magnetic declination -13.5

Software non-ASCII logs
Fluid type water
Fluid depth below LMP 10.82
at time 10.55

Hydrologic conditions ambient, pump 1.65 gal/min, start pump at 10:58 stop pump at 13:15, drawdown= 1.28ft
Type of log ZZ

Tool manufacturer and model, tool serial number, log date and time, logging direction and speed, depth error after logging, log parameter(s) and date(s) of calibration check

Tool run 1 Century 9065, 574,3/13/2007 -10:45, log up 20ft/min, depth error= 0.14ft, caliper cal check 10/21/2009.

Tool run 2 Century 9042-858,3/13/2007 - 11:18, log down 20 ft/min, depth error= 0.4 ft, gamma and ambient fluid temp and cond.

Tool run 3 Century 9510-746, 3/13/2007 -12:14, log up 20 ft/min, depth error= -0.04ft, gamma and formation conductivity.

Tool run 4 Century 9801-1106, 3/13/2007 -14:43, log up 10 ft/min, depth error= 0ft, acoustic image and deviation- in hole cal check.

Tool run 5 Mount Sopris -OBI-40, 000603, 3/13/2007 -18:03, log up 4 ft/min, depth error= 0.0ft, optical image and deviation- in hole cal check

Tool run 6 Mount Sopris - HPFM, HFP2060, 08:03, log down stationary measurments, ambient heat pulse flowmeter

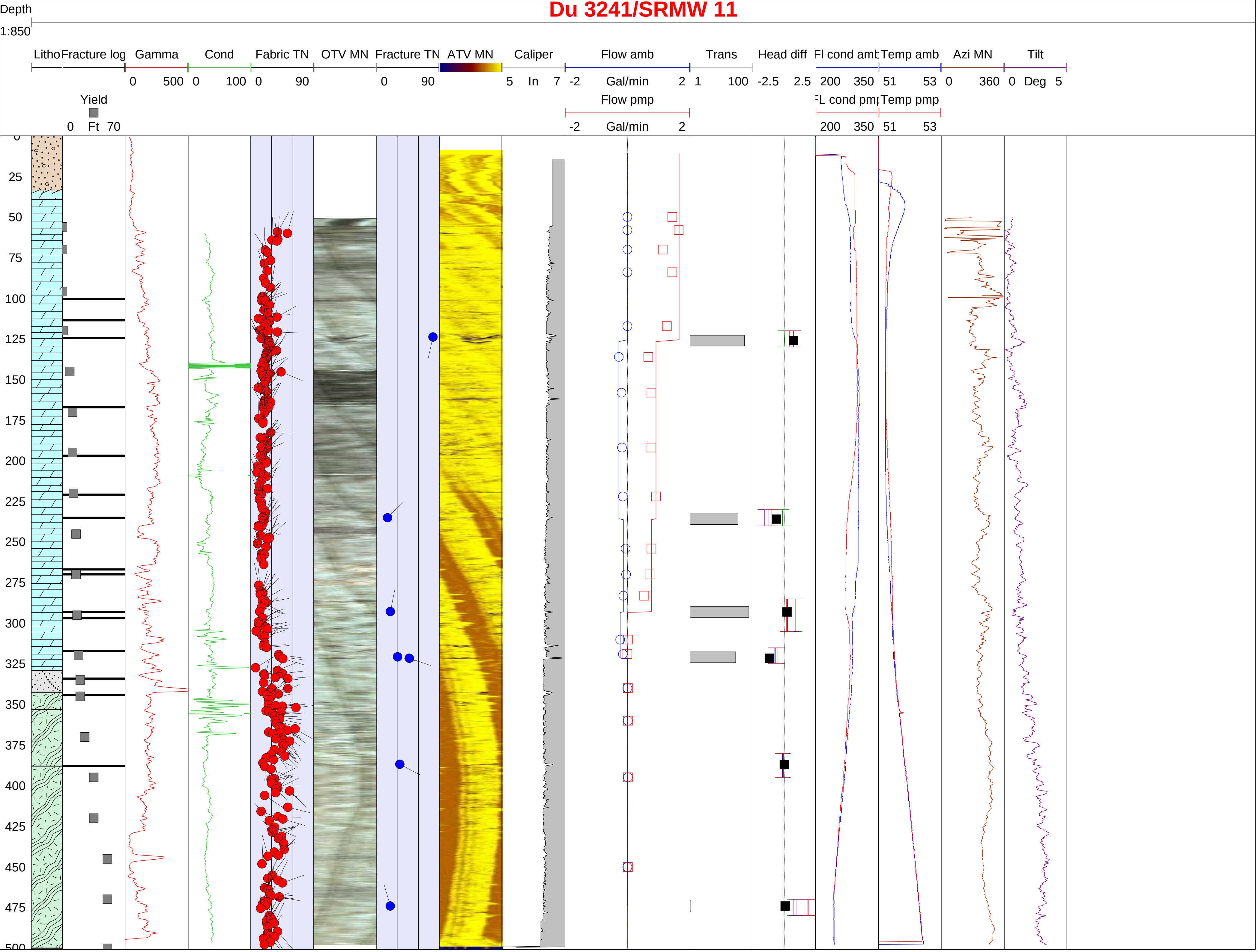
Tool run 7 Mount Sopris - HPFM, HFP2060, 11:15, log up stationary measurments, depth error= 0.57ft, pumping heat pulse flowmeter - in hole cal check.

Tool run 8 Century 9042-858, 12:49, log down 20 ft/min, depth error= 0.12 ft, gamma and pumping fluid temp and cond

Tool run 9

Remarks Casing stickup = 3.0ft above land surface,

Du 3241/SRMW 11



BOREHOLE GEOPHYSICAL LOG

English/Metric units E

SiteID (C1) 413203073472901 | **Station name (C12)** Du 3243 | **Other ID** SRMW-12R | **Log date** 6/26/2007

County Dutchess | **State** New York | **Project** CCW00 | **Recorded by** JAA | **Observed by** JDB

Location description | **Owner** Ground Water Sciences

Latitude 41 32 03.1 | **Longitude** 073 47 29.0 | **Lat/Long datum** NAD83 | **Log measurement point (LMP)** LS

Height LMP 0.0 | **Altitude LMP** 297.23 | **Altitude datum** NGVD29 | **Description of LMP** Land surface

Borehole depth 502 | **Borehole diameter** 6 | **Casing bottom** 269 | **Casing diameter** 6 | **Casing type** steel

Source of data USGS | **Logging unit** Troy | **Log orientiation** MN | **Magnetic declination** -13.5

Software non-ASCII logs | **Fluid type** water | **Fluid depth below LMP** flowing **at time**

Hydrologic conditions well flowing at 0.15Gal/min.pumped well down 14.46ft for recovery test, | **Type of log** ZZ

Tool manufacturer and model, tool serial number, log date and time, logging direction and speed, depth error after logging, log parameter(s) and date(s) of calibration check

Tool run 1 Century 9065, 574, 10:04, log up 25ft/min, depth error= 0.20ft, wellbore diameter in inches - in hole cal check.

Tool run 2 Century 9510, 746, 11:47, log up 25ft/min, depth error= 0.20ft, gamma in CPS and formation conductivity in uS/cm- free air cond cal check at surface.

Tool run 3 Mount Sopris- ABI-40, 3078-020906, 12:15, log up 5ft/min, depth error = 0.13ft, acoustic image and wellbore deviation-in hole cal check.

Tool run 4 Mount Sopris -OBI-40,00603, 13:10, log up 4 ft/min, depth error= 0.18ft, optical image and deviation- in hole cal check

Tool run 5 Century 9721-1162, 14:30, stationary, ambient stationary fluid flow -in-hole cal check

Tool run 6 Century 9721-1162, 14:17, log up 20ft/min,, ambient fluid temp/cond -in-hole cal check

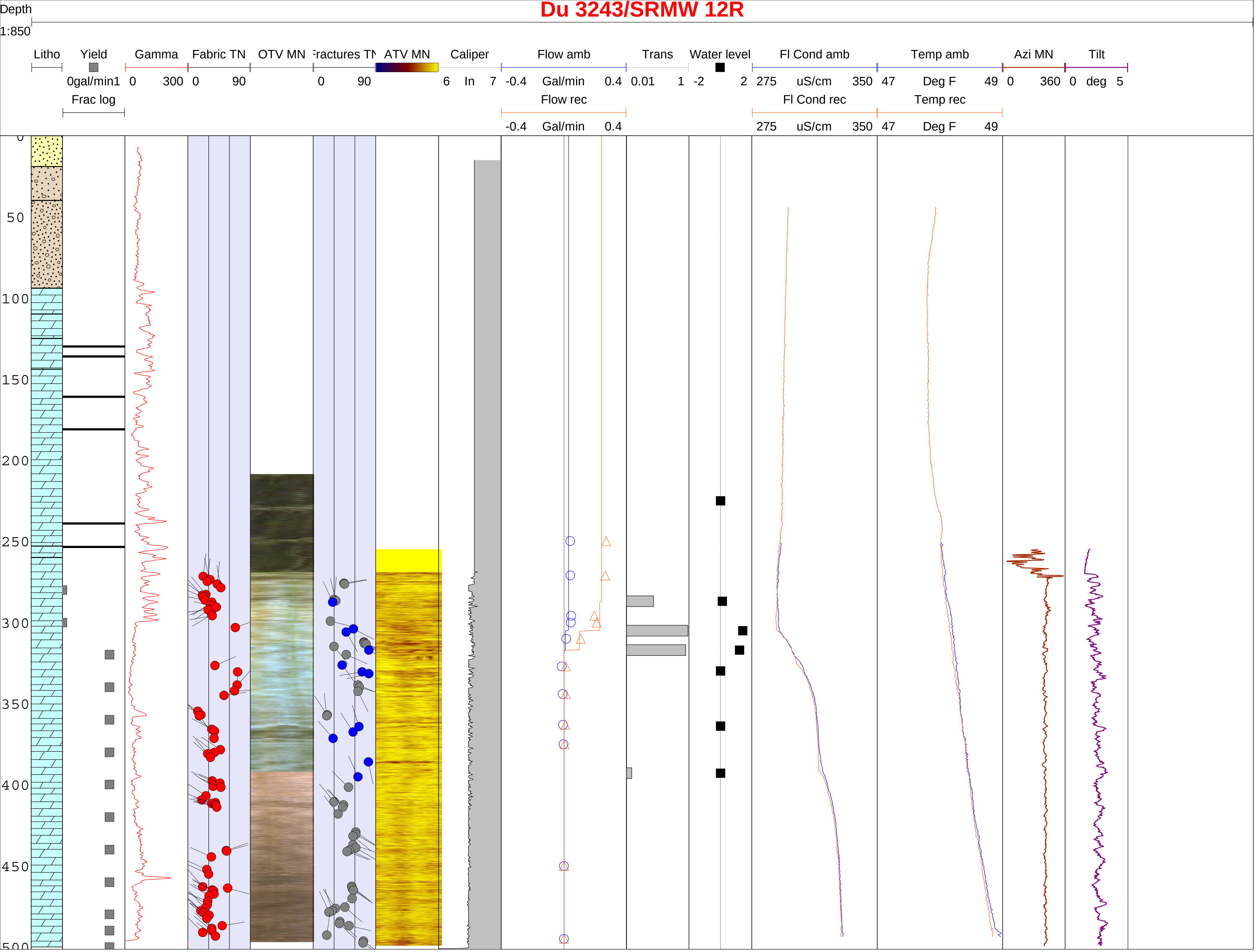
Tool run 7 Century 9721-1162, 17:01, log down 20ft/min, pumping fluid temp/cond

Tool run 8 Century 9721-1162, 17:33, stationary , pumping stationary fluid flow -in-hole cal check

Tool run 9

Remarks Casing stickup = 3.0ft above land surface.

Du 3243/SRMW 12R



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BOREHOLE GEOPHYSICAL LOG

English/Metric units E

SiteID (C1) 413151073473401 | **Station name (C12)** Du 3231 | **Other ID** SMRW-14 | **Log date** 11/21/2006

County Dutchess | **State** New York | **Project** CCW00 | **Recorded by** JAA | **Observed by** RJR

Location description | **Owner** Ground Water Science

Latitude 41 31 51.5 | **Longitude** 073 47 34.2 | **Lat/Long datum** NAD83 | **Log measurement point (LMP)** LS

Height LMP 0.0 | **Altitude LMP** 348.97 | **Altitude datum** NGVD29 | **Description of LMP** Land surface

Borehole depth 141 | **Borehole diameter** 6 | **Casing bottom** 90 | **Casing diameter** 6 | **Casing type** steel

Source of data USGS | **Logging unit** Troy | **Log orientiation** MN | **Magnetic declination** -13.5

Software non-ASCII logs | **Fluid type** water | **Fluid depth below LMP** 28.75 | **at time** 14:59

Hydrologic conditions ambient, pump 1.12gal/min, start pump at 15:00 stop pump at 16:23. Drawdown =1.59ft. | **Type of log** ZZ

Tool manufacturer and model, tool serial number, log date and time, logging direction and speed, depth error after logging, log parameter(s) and date(s) of calibration check

Tool run 1 Century 9065, 574,11:16, log up 20ft/min, depth error= -0.4ft, wellbore diameter in inches - in hole cal check.

Tool run 2 Century 9510-746,11:39, log up 20 ft/min, depth error= -0.2ft, gamma in CPS and formation conductivity in uS/m - free air conductivity cal check at surface.

Tool run 3 Century 9800-1106, 12:11, log up 10 ft/min, depth error= 0.2ft, acoustic image and deviation- in hole cal check.

Tool run 4 Mount Sopris- 2IDA, 3645, 12:57, log down 10ft/min,depth error = -0.2, ambient fluid temp/cond/redox/Cl/ O2 - factory calibration.

Tool run 5 Mount Sopris -OBI-40, 000603, 13:30, log up 4 ft/min, depth error= 0.0ft, optical image and deviation- in hole cal check

Tool run 6 Mount Sopris - HPFM, HFP2293, 14:16, log down stationary measurments, ambient heat pulse flowmeter - in hole cal check

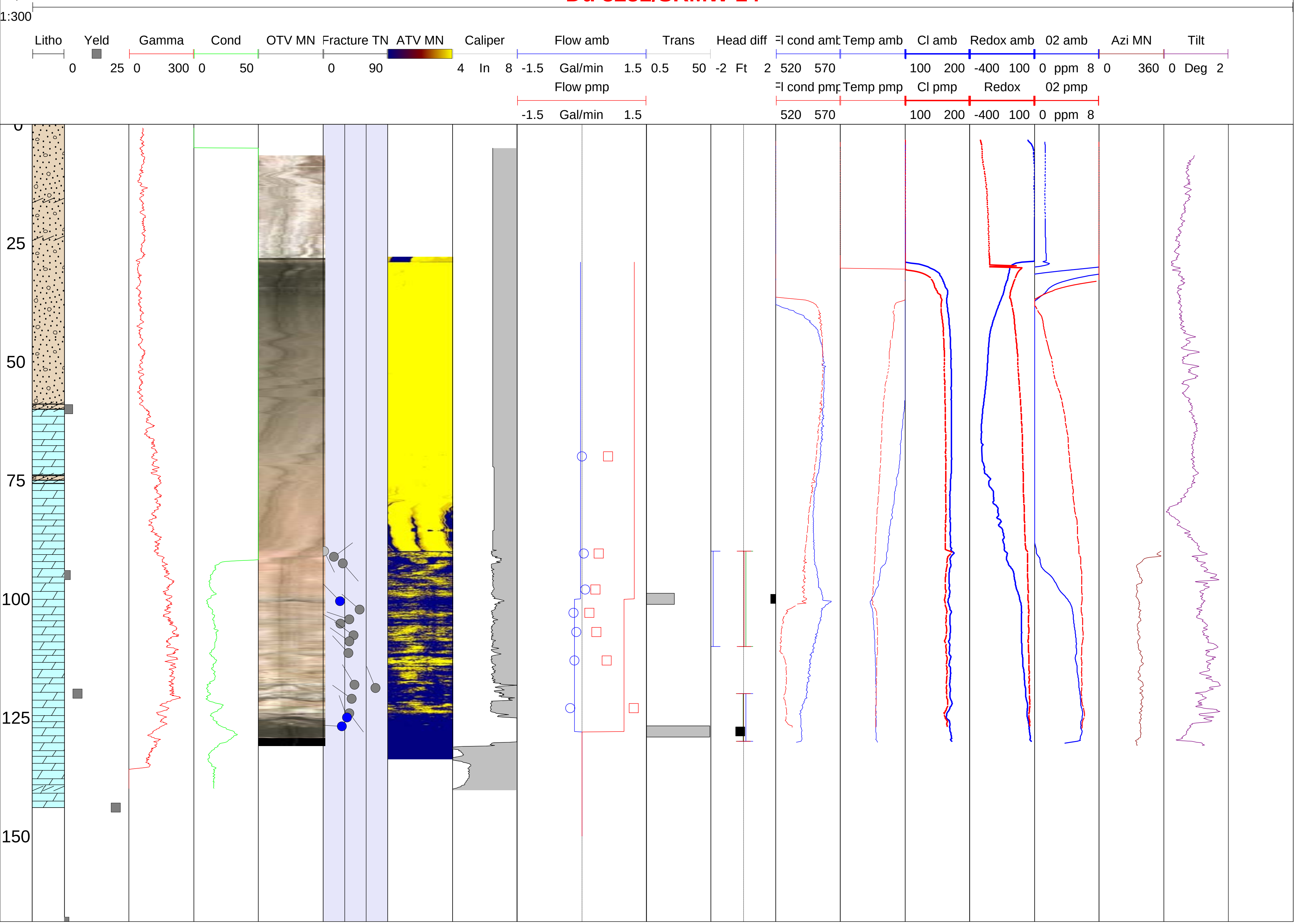
Tool run 7 Mount Sopris - HPFM, HFP2293, 15:26, log up stationary measurments, pumping heat pulse flowmeter - in hole cal check.

Tool run 8 Mount Sopris- 2IDA, 3645, 16:00, log down 10ft/min, pumping fluid temp/cond/redox/Cl/ O2 - factory calibration.

Tool run 9

Remarks Casing stickup =2.55ft above land surface

Du 3231/SRMW 14



BOREHOLE GEOPHYSICAL LOG

English/Metric units E

SiteID (C1) 413151073473402 | **Station name (C12)** Du 3232 | **Other ID** SRMW-14A | **Log date** 11/28/2006

County Dutchess | **State** New York | **Project** CCW00 | **Recorded by** JAA | **Observed by** RJR

Location description | **Owner**

Latitude 41 31 31.3 | **Longitude** 073 47 34.2 | **Lat/Long datum** NAD83 | **Log measurement point (LMP)** LS

Height LMP 0.0 | **Altitude LMP** 348.18 | **Altitude datum** NGVD29 | **Description of LMP** Land surface

Borehole depth 500 | **Borehole diameter** 6 | **Casing bottom** 145 | **Casing diameter** 6 | **Casing type** steel

Source of data USGS | **Logging unit** Troy | **Log orientiation** MN | **Magnetic declination** -13.5

Software non-ASCII logs | **Fluid type** water | **Fluid depth below LMP** 27.65 **at time** 12:15

Hydrologic conditions ambient, pump 1.15gal/min, start pump at 12:16 stop pump at 12:48 for recovery test, drawdown= 8.15ft | **Type of log** ZZ

Tool manufacturer and model, tool serial number, log date and time, logging direction and speed, depth error after logging, log parameter(s) and date(s) of calibration check

Tool run 1 Century 9065, 574, 11/27/2006 -10:16, log up 25ft/min, depth error= 0.37ft, borehole diameter in inches - in hole cal check.

Tool run 2 Century 9510-746, 11/27/2006-11:04, log up 20 ft/min, depth error= -0.02ft, gamma in CPS and formation conductivity in mS/m- conductivity free air check at surfacek.

Tool run 3 Century 9800-1106, 11/27/2006 - 11:55, log up 10 ft/min, depth error= 0.21ft, acoustic image and deviation- in hole cal check.

Tool run 4 Mount Sopris- 2IDA, 3645, 11/27/2006- 12:40 log down 10ft/min, depth error =-0.24, ambient fluid temp/cond/redox/Cl/ O2 - factory calibration.

Tool run 5 Mount Sopris -OBI-40, 000630, 11/27/2006 - 13:30, log up 10 ft/min, depth error= 0.18ft, optical image and deviation- in hole cal check

Tool run 6 Mount Sopris - HPFM, HFP2006, 10:08, log down stationary measurments, ambient wellbore flow - in hole cal check

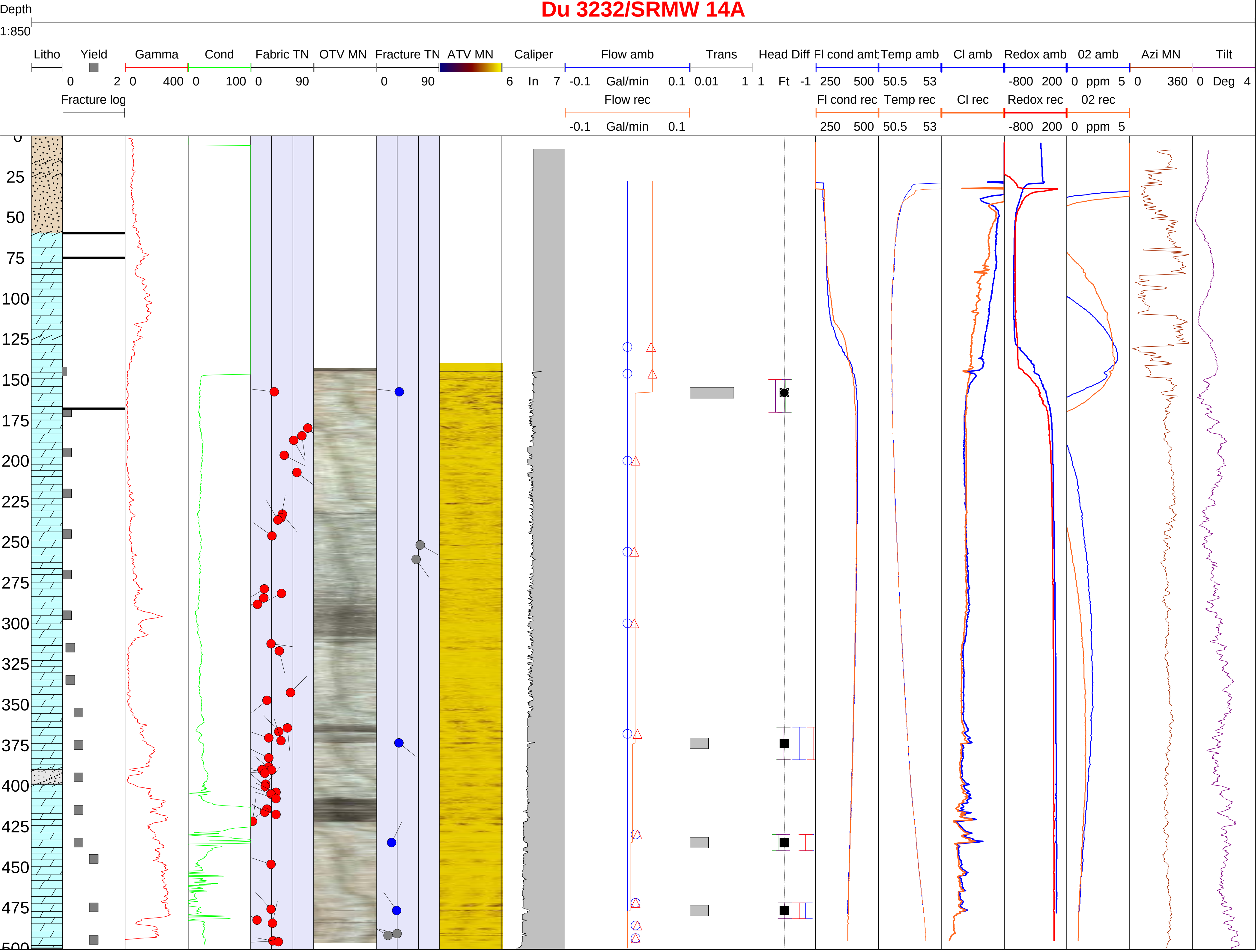
Tool run 7 Mount Sopris - HPFM, HFP2293, 12:46, log up stationary measurments, depth correction= -0.17ft, recovery heat pulse flowmeter - in hole cal check.

Tool run 8 Mount Sopris- 2IDA, 3645, 14:00, log down 10ft/min, depth error =-0.0, recovery fluid temp/cond/redox/Cl/ O2 - factory calibration.

Tool run 9

Remarks Casing stickup = 2.3ft above land surface.

Du 3232/SRMW 14A



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BOREHOLE GEOPHYSICAL LOG

English/Metric units E

SiteID (C1) 413145073472401	**Station name (C12)** Du 3230	**Other ID** SRMW-15	**Log date** 11/20/2006

County Dutchess	**State** New York	**Project** CCW00	**Recorded by** JAA	**Observed by** RJR

Location description	**Owner** Ground Water Science

Latitude 41 31 45.6	**Longitude** 073 47 24.2	**Lat/Long datum** NAD83	**Log measurement point (LMP)** LS
Height LMP 0.0	**Altitude LMP** 425.58	**Altitude datum** NGVD29	**Description of LMP** Land surface

Borehole depth 500	**Borehole diameter** 6	**Casing bottom** 66	**Casing diameter** 6	**Casing type** steel

Source of data USGS	**Logging unit** Troy	**Log orientiation** MN	**Magnetic declination** -13.5
Software non-ASCII logs	**Fluid type** water	**Fluid depth below LMP** 56.99	**at time** 16:34

Hydrologic conditions ambient, pump 1.3gal/min, start pump at 16:41 stop pump at 19:23, drawdown= 3.37ft	**Type of log** ZZ

Tool manufacturer and model, tool serial number, log date and time, logging direction and speed, depth error after logging, log parameter(s) and date(s) of calibration check

Tool run 1 Century 9065, 574, 11/17/2006 - 13:23, log up 25ft/min, depth error= -0.4ft, wellbore diameter in inches - in hole cal check.

Tool run 2 Century 9510-746,11/17/2006 - 14:12, log up 25 ft/min, depth error= 0.19t, gamma in CPS and formation conductivity in uS/m - free air conductivity cal check at surface.

Tool run 3 Century 9800-1106,11/17/2006 -13:23, log up 10 ft/min, acoustic image and deviation- in hole cal check.

Tool run 4 Mount Sopris- 2IDA, 3645, 10:00, log down 10ft/min,depth error = 0.09, ambient fluid temp/cond/Cl/ O2 - factory calibration.

Tool run 5 Mount Sopris -OBI-40, 000603, 08:00, log up 4 ft/min, depth error= 0.46ft, optical image and deviation- in hole cal check

Tool run 6 Mount Sopris - HPFM, HFP2060, 14:16, log down stationary measurments, ambient wellbore flow in gal/min - in hole cal check.

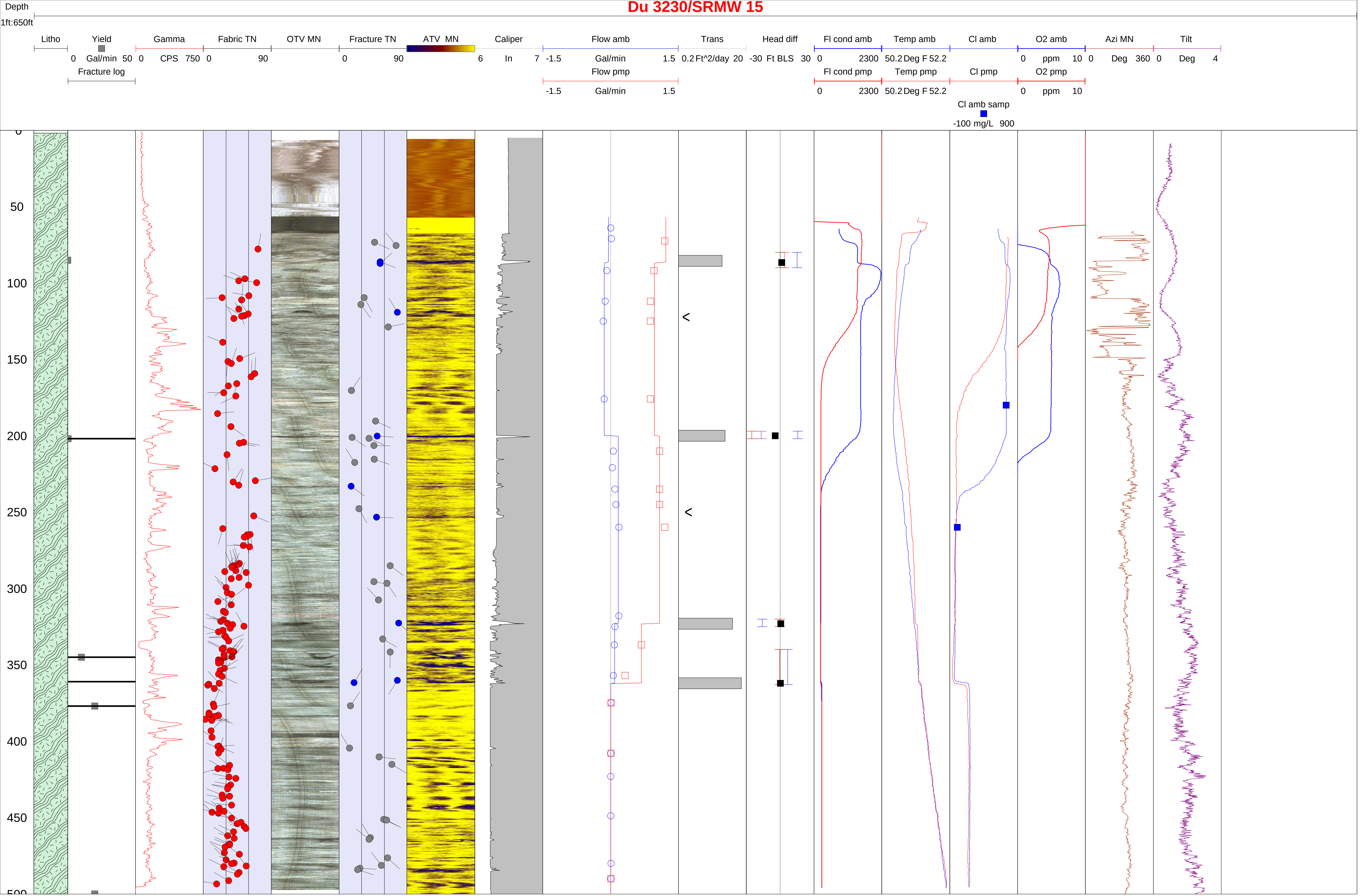
Tool run 7 Mount Sopris - HPFM, HFP2060, 17:17, log up stationary measurments, depth correction= 0.38ft, pumping wellbore flow in gal/min - in hole cal check.

Tool run 8 Mount Sopris- 2IDA, 3645, 18:30, log down 10ft/min,depth error = 0.0, pumping fluid temp/cond/Cl/ O2 - factory calibration.

Tool run 9

Remarks Casing stickup = 2.6ft above land surface,

Du 3230/SRMW 15



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BOREHOLE GEOPHYSICAL LOG

English/Metric units E

SiteID (C1) 413144073472501 | **Station name (C12)** Du 3242 | **Other ID** SRMW-16 | **Log date** 3/15/2007

County Dutchess | **State** New York | **Project** CCW00 | **Recorded by** JAA | **Observed by** JDB

Location description | **Owner** Ground Water Science

Latitude 41 31 44.8 | **Longitude** 073 47 25.3 | **Lat/Long datum** NAD83 | **Log measurement point (LMP)** LS

Height LMP 0.0 | **Altitude LMP** 417.75 | **Altitude datum** NGVD29 | **Description of LMP** Land surface

Borehole depth 500 | **Borehole diameter** 6 | **Casing bottom** 30.5 | **Casing diameter** 6 | **Casing type** steel

Source of data USGS | **Logging unit** Troy | **Log orientiation** MN | **Magnetic declination** -13.5

Software non-ASCII logs | **Fluid type** water | **Fluid depth below LMP** 28.75 **at time** 12:17

Hydrologic conditions ambient, pump 0.8 gal/min, start pump at 12:29 stop pump at 14:14, drawdown= 2.04ft | **Type of log** ZZ

Tool manufacturer and model, tool serial number, log date and time, logging direction and speed, depth error after logging, log parameter(s) and date(s) of calibration check

Tool run 1 Century 9065, 574, 3/14/2007 -14:36, log up 25ft/min, depth error= -0.15ft, wellbore diameter in inches- in hole cal.

Tool run 2 Century 9042-858, 3/14/2007-.15:05 , log down 20 ft/min, depth error= -0.02 ft, gamma in CPS and ambient fluid temp in deg F and cond in uS/cm- fluid temp and cond in hole cal check.

Tool run 3 Century 9510, 746, 3/14/2007 - 15:53, log up 20ft/min, depth error= -.05ft, formation conductivity in uS/cm- cond cal 1/18/2010.

Tool run 4 Century 9620, 1046, 3/14/2007 - 16:30 , log up 20 ft/min, depth error= 0.03ft, mag suscept and dev- mag suscept free air cal check

Tool run 5 Century 9800-1106, 3/14/2007- 17:04, log up 10 ft/min, depth error= 0.13ft, acoustic image and deviation- in hole cal check.

Tool run 6 Mount Sopris -OBI-40, 000603, 08:30, log up 4 ft/min, depth error= 0.46ft, optical image and deviation- in hole cal check

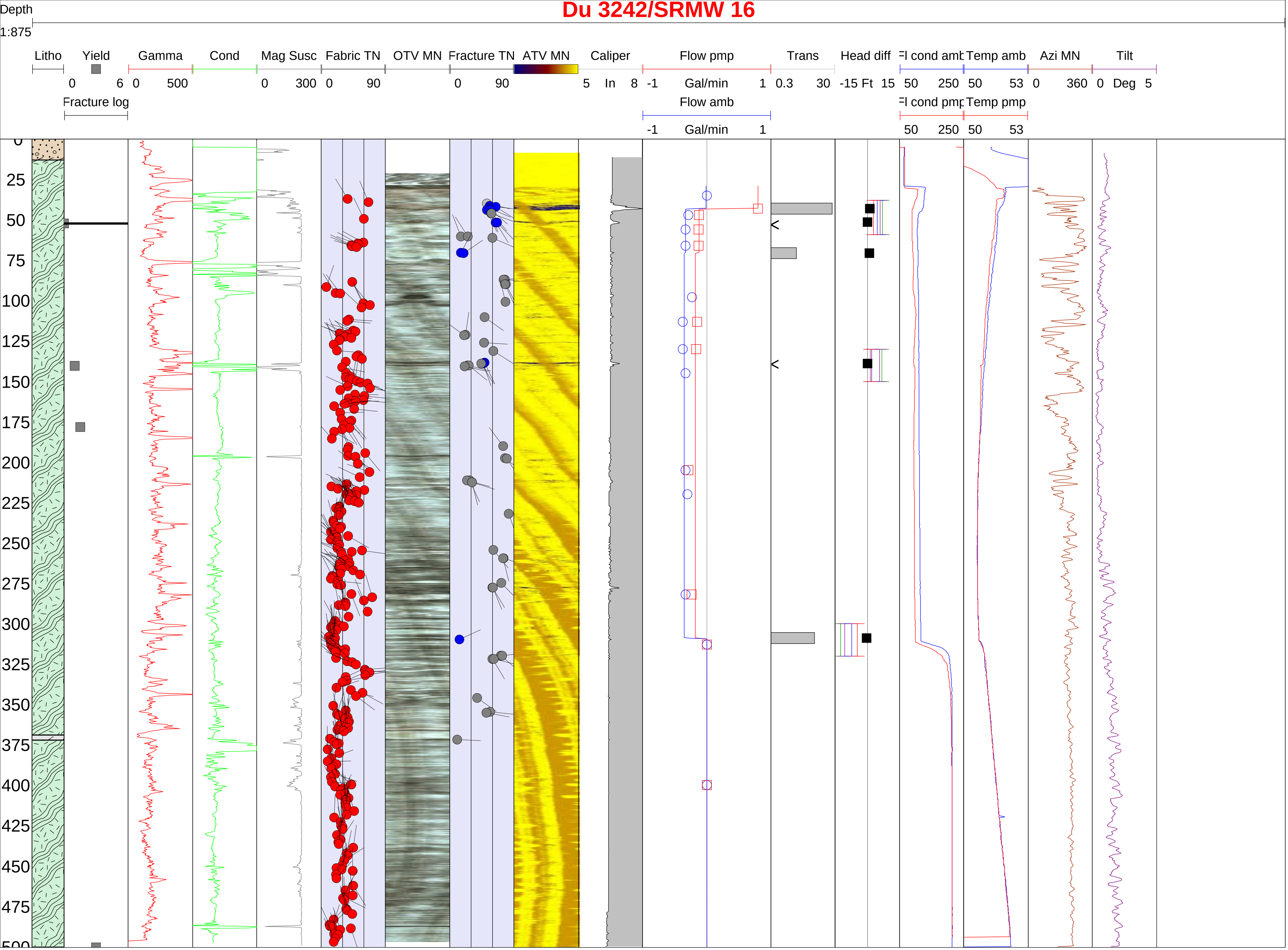
Tool run 7 Mount Sopris - HPFM, HFP2060, 10:57, log down stationary measurments, ambient wellbore flow in gal/min - in hole cal check.

Tool run 8 Mount Sopris - HPFM, HFP2060, 12:50, log up stationary measurmentst, pumping wellbore flow in gal/min - in hole cal check.

Tool run 9 Century 9042-858, 14:00 , log down 20 ft/min,, gamma in CPS and pumping fluid temp in deg F and cond in uS/cm- fluid temp and cond in hole cal check.

Remarks Casing stickup = 2.7ft above land surface,

Du 3242/SRMW 16



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BOREHOLE GEOPHYSICAL LOG

English/Metric units E

SiteID (C1) 413139073472301
Station name (C12) Du 3234
Other ID SRMW-17
Log date 12/12/2006

County Dutchess
State New York
Project CCW00
Recorded by JAA
Observed by RJR

Location description
Owner Ground Water Science

Latitude 41 31 39.5
Longitude 073 47 23.6
Lat/Long datum NAD83
Log measurement point (LMP) LS

Height LMP 0.0
Altitude LMP 384.01
Altitude datum NGVD29
Description of LMP Land surface

Borehole depth 500
Borehole diameter 6
Casing bottom 18
Casing diameter 6
Casing type steel

Source of data USGS
Logging unit Troy
Log orientiation MN
Magnetic declination -13.5

Software non-ASCII logs
Fluid type water
Fluid depth below LMP 17.70
at time 11:06

Hydrologic conditions ambient, pump 0.5 gal/min, start pump at 11:33 stop pump at 14:36, drawdown= 7.5ft
Type of log ZZ

Tool manufacturer and model, tool serial number, log date and time, logging direction and speed, depth error after logging, log parameter(s) and date(s) of calibration check

Tool run 1 Century 9065, 574, 9:57, log up 25ft/min, depth error= 0..45ft, well diameter in inches - in hole cal check.

Tool run 2 Century 9510-746, 10:57, log up 25 ft/min, depth error= 0.24ft, gamma in CPS and formation conductivity in uS/m- free air conductivity cal check at surface.

Tool run 3 Century 9800-1106, 12:33, log up 10 ft/min, depth error= -0.40ft, acoustic image and deviation- in hole cal check.

Tool run 4 Mount Sopris -OBI-40, 000603, 11:00, log up 4 ft/min, depth error= 0.1ft, optical image and deviation- in hole cal check

Tool run 5 Mount Sopris - 2PMA, log up 25 ft/min, depth error = -0.46ft, magnetic susceptibility, free air cal check.

Tool run 6 Mount Sopris- 2IDA, 3645, log down 10ft/min, ambient fluid temp/cond/redox/Cl/ O2 - factory calibration.

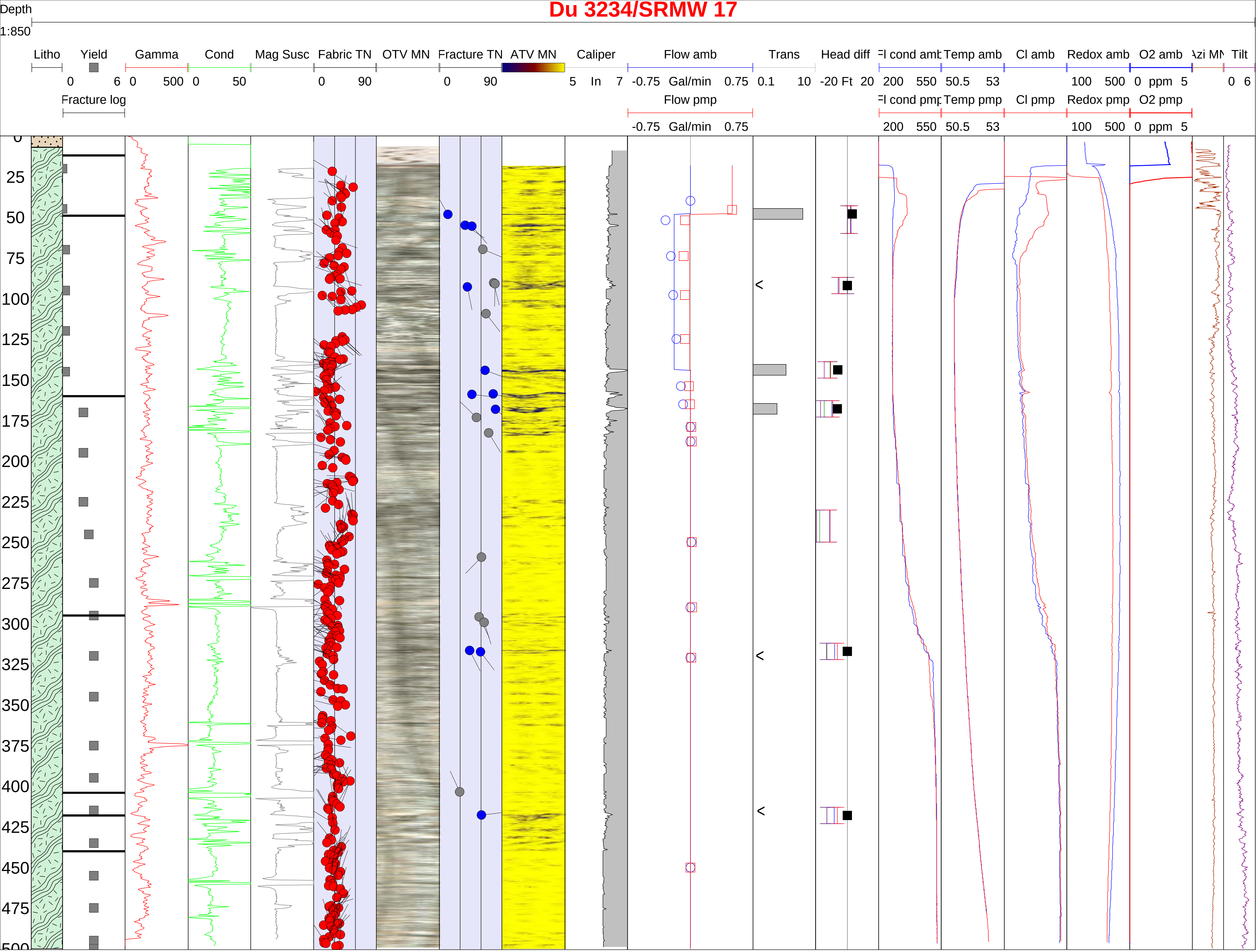
Tool run 7 Mount Sopris - HPFM, HFP2060, 09:18, log down stationary measurments, ambient heat pulse flowmeter

Tool run 8 Mount Sopris - HPFM, HFP2293, 13:34, log up stationary measurments, depth error= 0.25ft, pumping heat pulse flowmeter - in hole cal check.

Tool run 9 Mount Sopris- 2IDA, 3645, log down 10ft/min, pumping fluid temp/cond/redox/Cl/ O2 - factory calibration.

Remarks Casing stickup = 1.2ft above land surface

Du 3234/SRMW 17



BOREHOLE GEOPHYSICAL LOG

English/Metric units E

SiteID (C1) 413135073473401 | **Station name (C12)** Du 3227 | **Other ID** 18-core | **Log date** 1/19/2006

County Dutchess | **State** New York | **Project** CCW00 | **Recorded by** JAA | **Observed by**

Location description | **Owner** Ground Water Sciences

Latitude 41 31 35 | **Longitude** 073 47 34 | **Lat/Long datum** NAD83 | **Log measurement point (LMP)** LS

Height LMP 0.0 | **Altitude LMP** 505.00 | **Altitude datum** NGVD29 | **Description of LMP** Land surface

Borehole depth 126.5 | **Borehole diameter** 4 | **Casing bottom** 29.1 | **Casing diameter** 4 | **Casing type** steel

Source of data USGS | **Logging unit** Troy | **Log orientiation** MN | **Magnetic declination** -13.5

Software non-ASCII logs | **Fluid type** water | **Fluid depth below LMP** 2.47 | **at time** 10:20

Hydrologic conditions ambient, pump 1.7 gal/min, start pump at 10:24 stop pump at 11:57, drawdown= 7.3ft: | **Type of log** ZZ

Tool manufacturer and model, tool serial number, log date and time, logging direction and speed, depth error after logging, log parameter(s) and date(s) of calibration check

Tool run 1 Century 9065, 715,1/18/2006- 09:17, log up 20ft/min, depth error= -0.05ft, well diameter - in hole cal check.

Tool run 2 Century 9042-858,1/18/2006- 09:37, log down 20 ft/min, depth error= 0.05ft, gamma and ambient fluid cond and temp.

Tool run 3 Century 9620-1046, 1/18/2006- 10:05, log up 20 ft/min, depth error= 0.5ft, mag suscept, gamma and deviation.

Tool run 4 Mount Sopris -OBI-40, 000603, 1/18/2006-11:54, log up 4 ft/min, depth error= 0.1ft, optical image and deviation- in hole cal check

Tool run 5 Mount Sopris -ABI-40, 020906, 1/18/2006-13:26, log up 4 ft/min, depth error= 0.1ft, acoustic image and deviation- in hole cal check

Tool run 6 Mount Sopris - HPFM, HFP2060, 09:17, log down stationary measurments, ambient heat pulse flowmeter

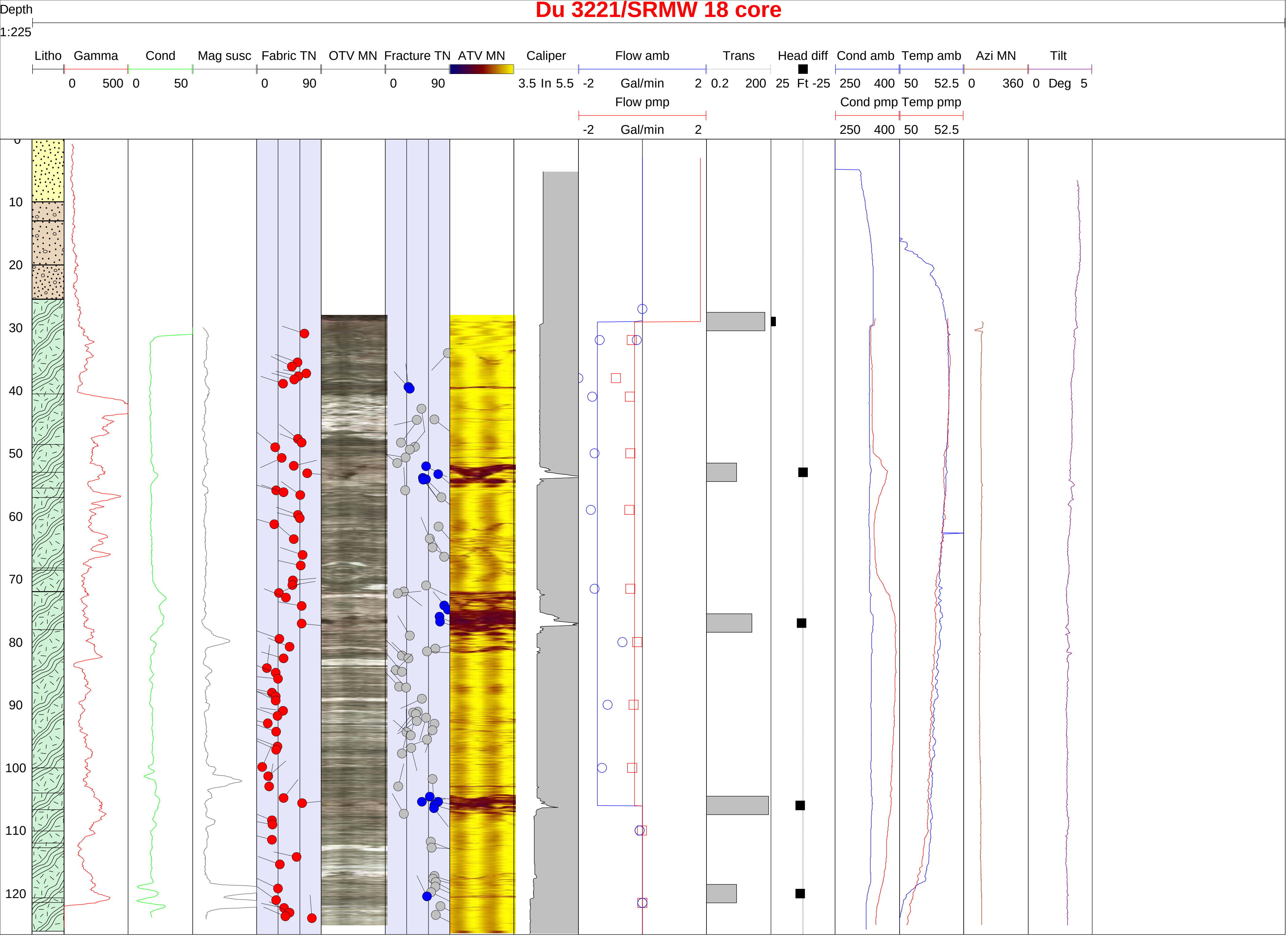
Tool run 7 Mount Sopris - HPFM, HFP2060,10:53, log up stationary measurments, depth correction= 0.25ft, pumping heat pulse flowmeter - in hole cal check.

Tool run 8 Century 9042-858,1/18/2006- 09:37, log down 20 ft/min, depth error= 0.05ft, gamma and pumping fluid cond and temp.

Tool run 9

Remarks Casing stickup = 2.7ft above land surface

Du 3221/SRMW 18 core



BOREHOLE GEOPHYSICAL LOG

English/Metric units E

SiteID (C1) 413136073473501
Station name (C12) Du 3239
Other ID SRMW-18A
Log date 2/21/07

County Dutchess
State New York
Project CCW00
Recorded by JAA
Observed by RJR

Location description
Owner Ground Water Sciences

Latitude 41 31 35.7
Longitude 073 47 35.3
Lat/Long datum NAD83
Log measurement point (LMP) LS

Height LMP 0.0
Altitude LMP 504.56
Altitude datum NGVD29
Description of LMP Land surface

Borehole depth 80
Borehole diameter 6
Casing bottom 44.5
Casing diameter 6
Casing type steel

Source of data USGS
Logging unit Troy
Log orientiation MN
Magnetic declination -13.5

Software non-ASCII logs
Fluid type water
Fluid depth below LMP 30.49
at time 11:09

Hydrologic conditions ambient. Slug well with 2.5 gal specific capacity = .016 (gal/min)/ft
Type of log ZZ

Tool manufacturer and model, tool serial number, log date and time, logging direction and speed, depth error after logging, log parameter(s) and date(s) of calibration check

Tool run 1 Century 9065, 715, 11:28, log up 20ft/min, depth error= 0.05ft, well diameter - in hole cal check.

Tool run 2 Century 9042-858, 09:37, log down 20 ft/min, depth error= -0.04ft, gamma and ambient fluid cond and temp.

Tool run 3 Century 9510-746, 12:24, log up 15 ft/min, depth error= -0.05ft, gamma and formation conductivity.

Tool run 4 Century 9620-1046, 13:37, log up 15ft/min, mag suscept, gamma and deviation- mag suscept cal 2-07.

Tool run 5 Century 9800-1106, 14:04, log up 12 ft/min, depth error= 0ft, acoustic image and deviation- in hole cal check.

Tool run 6 Mount Sopris -OBI-40, 000603, 16:06, log up 4 ft/min, depth error= 0ft, optical image and deviation- in hole cal check

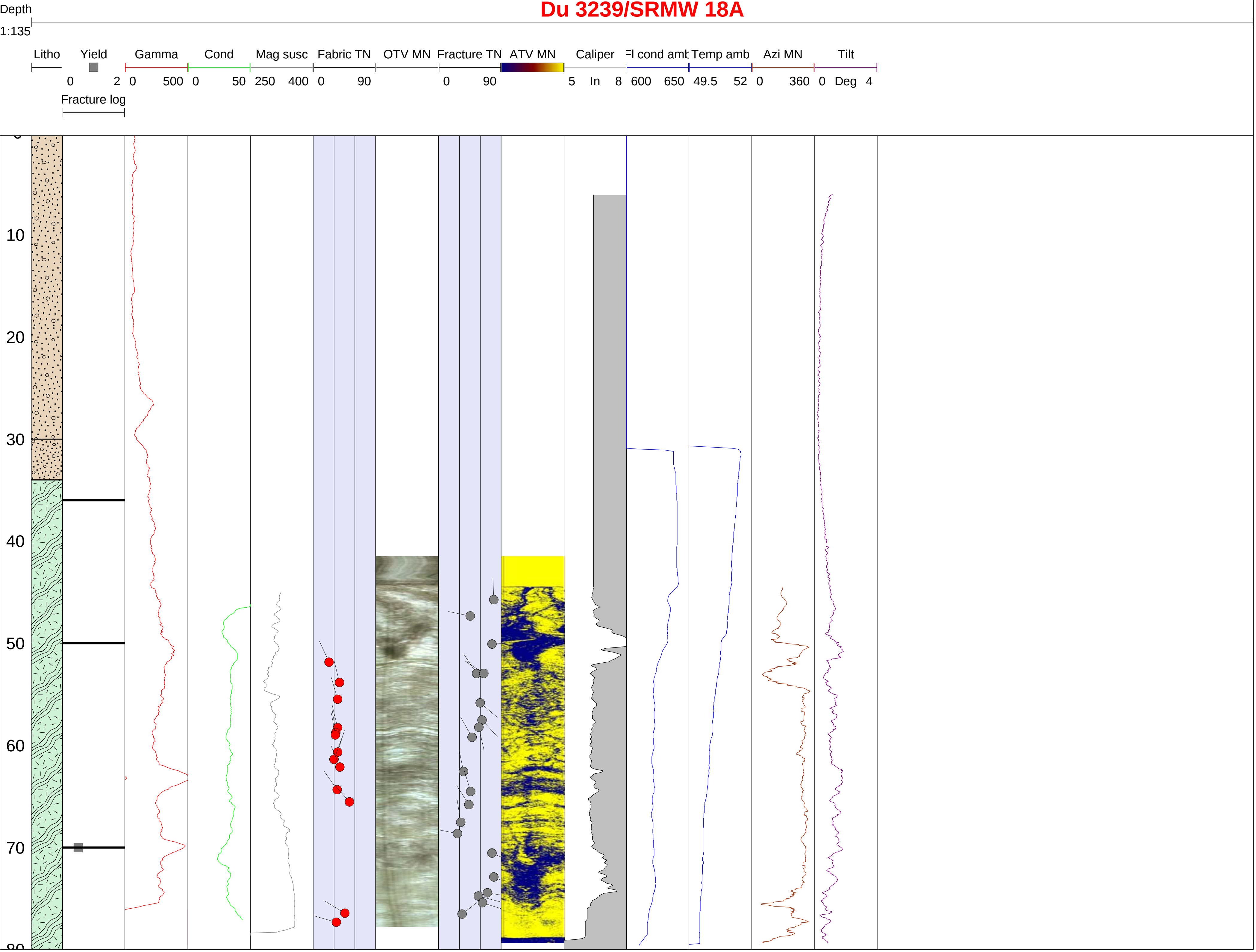
Tool run 7

Tool run 8

Tool run 9

Remarks Casing stickup = 3.4ft above land surface,

Du 3239/SRMW 18A



BOREHOLE GEOPHYSICAL LOG

English/Metric units E

SiteID (C1) 413136073473401 | **Station name (C12)** Du 3236 | **Other ID** SRMW-18B | **Log date** 2/21/2007

County Dutchess | **State** New York | **Project** CCW00 | **Recorded by** JAA | **Observed by** RJR

Location description | **Owner** Ground Water Sciences

Latitude 41 31 36 | **Longitude** 073 47 34 | **Lat/Long datum** NAD83 | **Log measurement point (LMP)** LS

Height LMP 0.0 | **Altitude LMP** 504.28 | **Altitude datum** NGVD29 | **Description of LMP** Land surface

Borehole depth 160 | **Borehole diameter** 6 | **Casing bottom** 101 | **Casing diameter** 6 | **Casing type** steel

Source of data USGS | **Logging unit** Troy | **Log orientiation** MN | **Magnetic declination** -13.5

Software non-ASCII logs | **Fluid type** water | **Fluid depth below LMP** 17.71 **at time** 16:35

Hydrologic conditions ambient, pump 0.6 gal/min, start pump at 17:25 stop pump at 18:20, drawdown= 3.35ft: | **Type of log** ZZ

Tool manufacturer and model, tool serial number, log date and time, logging direction and speed, depth error after logging, log parameter(s) and date(s) of calibration check

Tool run 1 Century 9065, 715, 08:40, log up 20ft/min, depth error= 0ft, well diameter - in hole cal check.

Tool run 2 Century 9042-858, 12:14, log down 20 ft/min, depth error= 0.05ft, gamma and fluid cond and temp.

Tool run 3 Century 9510-746, 12:04, log up 20 ft/min, depth error= -0.11ft, gamma and formation conductivity.

Tool run 4 Century 9620-1046, 13:12, log up 20ft/min, depth error = 0ft, gamma, well deviation and magnetic suscept- mag cal check 2/20/2007

Tool run 5 Century 9800-1106, 14:20, log up 10 ft/min, depth error= -0.40ft, acoustic image and well deviation- in hole cal check.

Tool run 6 Mount Sopris -OBI-40, 000603, 15:32, log up 4 ft/min, depth error= 0.1ft, optical image and well deviation- in hole cal check

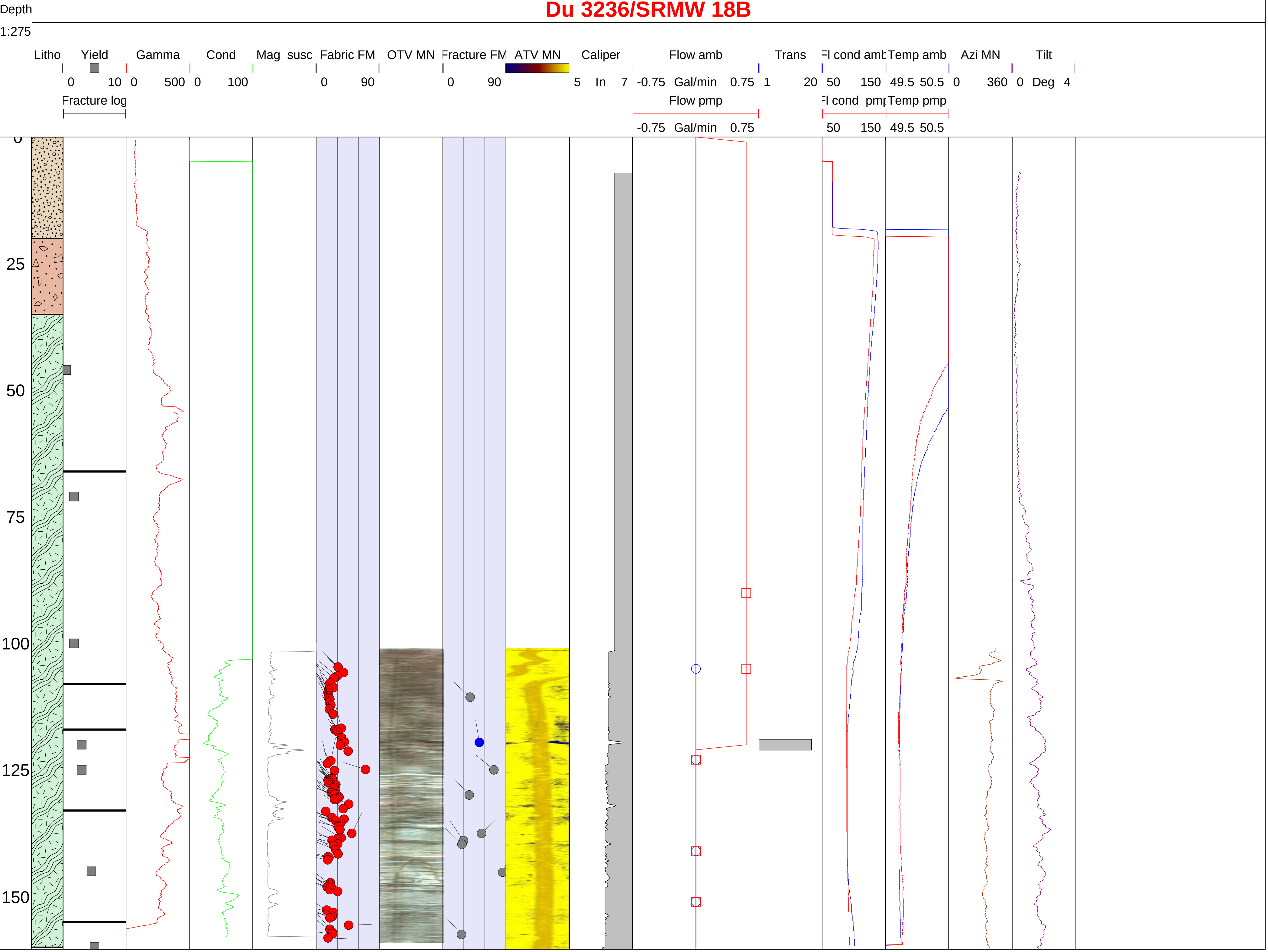
Tool run 7 Mount Sopris - HPFM, HFP2060, 16:42, log down stationary measurments, ambient heat pulse flowmeter

Tool run 8 Mount Sopris - HPFM, HFP2060, 17:42, log up stationary measurments, depth correction= 0ft, pumping heat pulse flowmeter - in hole cal check.

Tool run 9 Century 9042-858, 12:14, log down 20 ft/min, depth error= 0.05ft, gamma and fluid cond and temp.

Remarks Casing stickup = 3.0ft above land surface,

Du 3236/SRMW 18B



BOREHOLE GEOPHYSICAL LOG

English/Metric units E

SiteID (C1) 413135073473402
Station name (C12) Du 3233
Other ID SRMW-18C
Log date 12/8/2007

County Dutchess
State New York
Project CCW00
Recorded by JAA
Observed by RJR

Location description
Owner Ground Water Sciences

Latitude 41 31 35
Longitude 073 47 34
Lat/Long datum NAD83
Log measurement point (LMP) LS

Height LMP 0.0
Altitude LMP 507.46
Altitude datum NGVD29
Description of LMP Land surface

Borehole depth 247
Borehole diameter 6
Casing bottom 155
Casing diameter 6
Casing type steel

Source of data USGS
Logging unit Troy
Log orientiation MN
Magnetic declination -13.5

Software non-ASCII logs
Fluid type water
Fluid depth below LMP 32.10
at time 08:00

Hydrologic conditions ambient, pump 0.7 gal/min, start pump at 11:04 stop pump at 13:06, drawdown= 10.80ft
Type of log ZZ

Tool manufacturer and model, tool serial number, log date and time, logging direction and speed, depth error after logging, log parameter(s) and date(s) of calibration check

Tool run 1 Century 9065, 715, 12/7/2007 -13:02,log up 15ft/min, well diameter - in hole cal check.

Tool run 2 Century 9510-746, 12/7/2007 - 13:38, log up 15 ft/min, gamma and formation conductivity.

Tool run 3 Century 9800-1106, 12:33, log up 10 ft/min, acoustic image and deviation- in hole cal check.

Tool run 4 Mount Sopris -OBI-40, 000603,12/7/2007 - 15:19, log up 4 ft/min, optical image and deviation- in hole cal check

Tool run 5 Mount Sopris- 2IDA, 3645, 08:47, log down 10ft/min, ambient fluid temp/cond/redox/Cl/ O2 - factory calibration.

Tool run 6 Mount Sopris - HPFM, HFP2060, 10:42, log down stationary measurments, ambient heat pulse flowmeter

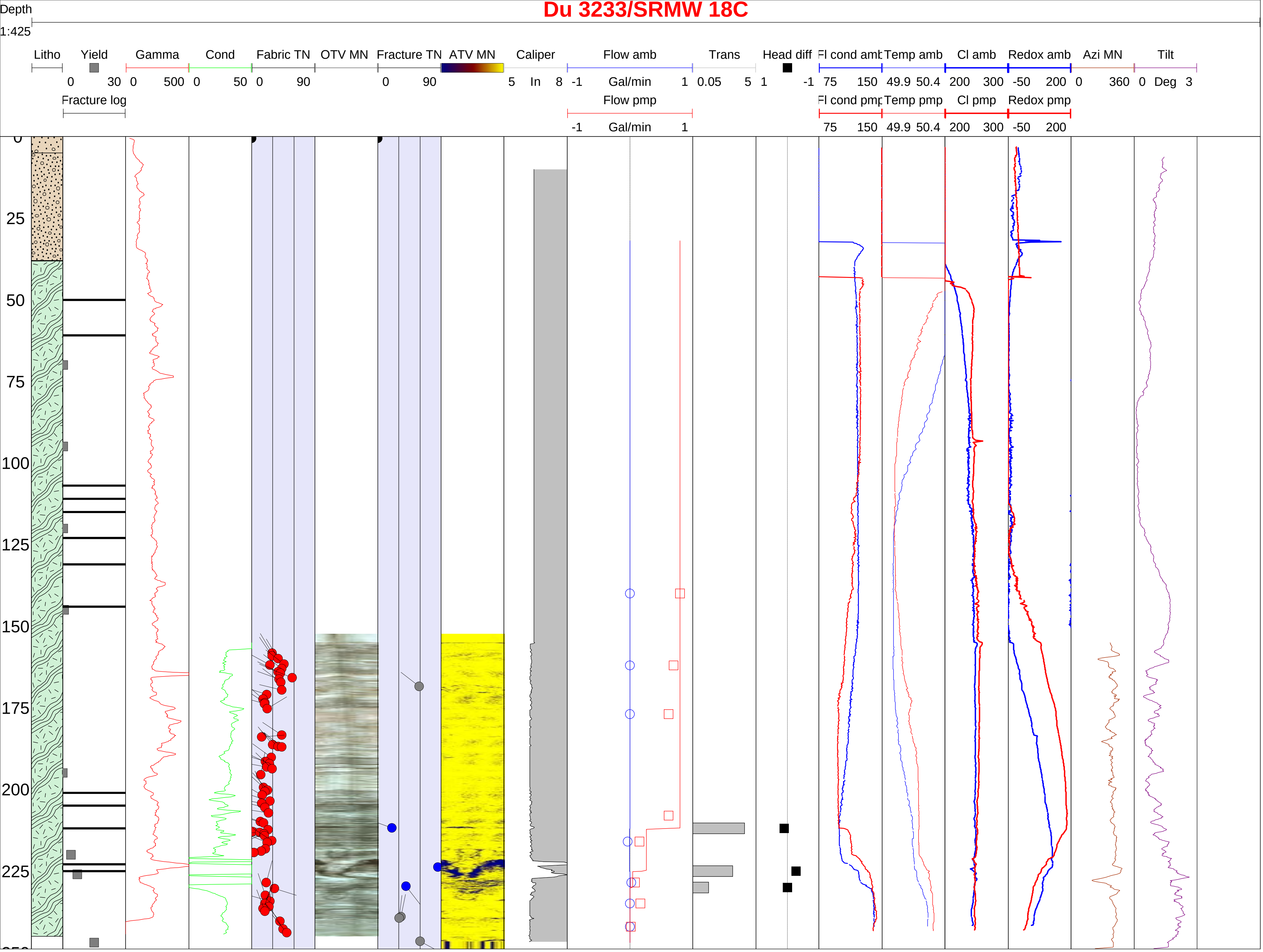
Tool run 7 Mount Sopris - HPFM, HFP2060, 13:34, log up stationary measurments, pumping heat pulse flowmeter - in hole cal check.

Tool run 8 Mount Sopris- 2IDA, 3645, 12:56, log down 10ft/min, pumping fluid temp/cond/redox/Cl/ O2 - factory calibration.

Tool run 9

Remarks Casing stickup = 1.2ft above land surface

Du 3233/SRMW 18C



BOREHOLE GEOPHYSICAL LOG

English/Metric units E

SiteID (C1) 413139073472301 | **Station name (C12)** Du 3237 | **Other ID** SRMW-18D | **Log date** 12/20/2006

County Dutchess | **State** New York | **Project** CCW00 | **Recorded by** JAA | **Observed by** RJR

Location description

Owner Ground water Sciences

Latitude 413135.7 | **Longitude** 0734735.3 | **Lat/Long datum** NAD83 | **Log measurement point (LMP)** LS

Height LMP 0.0 | **Altitude LMP** 504.62 | **Altitude datum** NGVD29 | **Description of LMP** Land surface

Borehole depth 320 | **Borehole diameter** 6 | **Casing bottom** 248 | **Casing diameter** 6 | **Casing type** steel

Source of data USGS | **Logging unit** Troy | **Log orientiation** MN | **Magnetic declination** -13.5

Software non-ASCII logs

Fluid type water | **Fluid depth below LMP** 63.98 | **at time** 15:15

Hydrologic conditions ambient, pump 0.6 gal/min, start pump at 15:15 stop pump at 16:20, drawdown= 7.62ft

Type of log ZZ

Tool manufacturer and model, tool serial number, log date and time, logging direction and speed, depth error after logging, log parameter(s) and date(s) of calibration check

Tool run 1 Century 9065, 574, 10:25, log up 20ft/min, depth error= -0.45ft, well diameter - in hole cal check.

Tool run 2 Century 9510-746, 10:53, log up 25 ft/min, depth error= 0.24ft, gamma and formation conductivity.

Tool run 3 Century 9800-1106, 11:26, log up 10 ft/min, depth error= 0ft, acoustic image and deviation- in hole cal check.

Tool run 4 Mount Sopris -OBI-40, 000603, 12:30, log up 4 ft/min, depth error= 0.04ft, optical image and deviation- in hole cal check

Tool run 5 Mount Sopris - 2PMA, 13:01, log up 20 ft/min, depth error = 0ft, magnetic susceptibility, free air cal check.

Tool run 6 Mount Sopris- 2IDA, 3645, 13:37, log down 10ft/min, ambient fluid temp/cond/redox/Cl/ O2 - factory calibration.

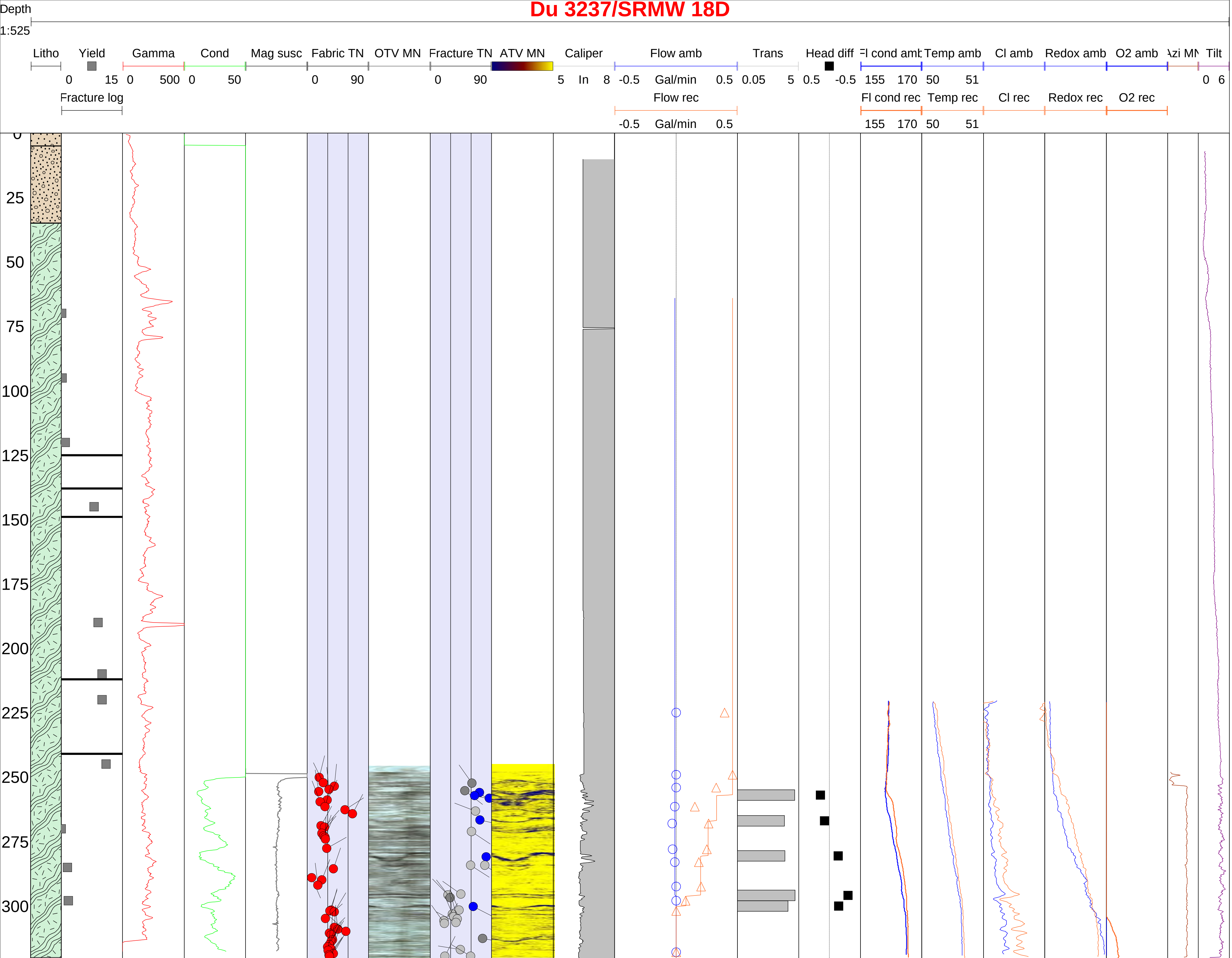
Tool run 7 Mount Sopris - HPFM, HFP2060, 14:08, log down stationary measurments, ambient heat pulse flowmeter

Tool run 8 Mount Sopris - HPFM, HFP2293, 15:29, log up stationary measurments, depth errot= 0ft, pumping heat pulse flowmeter - in hole cal check.

Tool run 9 Mount Sopris- 2IDA, 3645, 16:50, log down 10ft/min, pumping fluid temp/cond/redox/Cl/ O2 - factory calibration.

Remarks Casing stickup = 3.0ft above land surface

Du 3237/SRMW 18D



BOREHOLE GEOPHYSICAL LOG

English/Metric units E

SiteID (C1) 413135073473502
Station name (C12) Du 3238
Other ID SRMW-18E
Log date 1/24/2007

County Dutchess
State New York
Project CCW00
Recorded by JAA
Observed by RJR

Location description
Owner Ground Water Sciences

Latitude 41 31 35.5
Longitude 073 47 35.5
Lat/Long datum NAD83
Log measurement point (LMP) LS

Height LMP 0.0
Altitude LMP 504.62
Altitude datum NGVD29
Description of LMP Land surface

Borehole depth 275
Borehole diameter 9
Casing bottom 40.5
Casing diameter 10
Casing type steel

Source of data USGS
Logging unit Troy
Log orientiation MN
Magnetic declination -13.5

Software non-ASCII logs
Fluid type water
Fluid depth below LMP 19.42
at time 11:14

Hydrologic conditions ambient, pump 2.2 gal/min, start pump at 11:15 stop pump at 14:04, drawdown= 1.43ft:
Type of log ZZ

Tool manufacturer and model, tool serial number, log date and time, logging direction and speed, depth error after logging, log parameter(s) and date(s) of calibration check

Tool run 1 Century 9065, 715, 1/23/2007 - 11:27, log up 15ft/min, depth error= -0.09ft, well diameter - in hole cal check.

Tool run 2 Century 9510-746, 1/23/2007 -12:02, log up 15 ft/min, depth error= 0.06ft, gamma and fromation cond.

Tool run 3 Century 9800-1106, 1/23/2007 -12:48, log up 12 ft/min, depth error= 0.2ft, mag suscept, gamma and deviation.

Tool run 4 Mount Sopris -OBI-40, 000603, 1/23/2007 -15:53, log up 4 ft/min, depth error= 0.1ft, optical image and deviation- in hole cal check

Tool run 5 Mount Sopris- 2IDA, 3645,1/23/2007 - 14:06, log down 10ft/min, ambient fluid temp/cond/redox/Cl/ O2 - factory calibration.

Tool run 6 Mount Sopris - HPFM, HFP2060, 09:06, log down stationary measurments, ambient heat pulse flowmeter

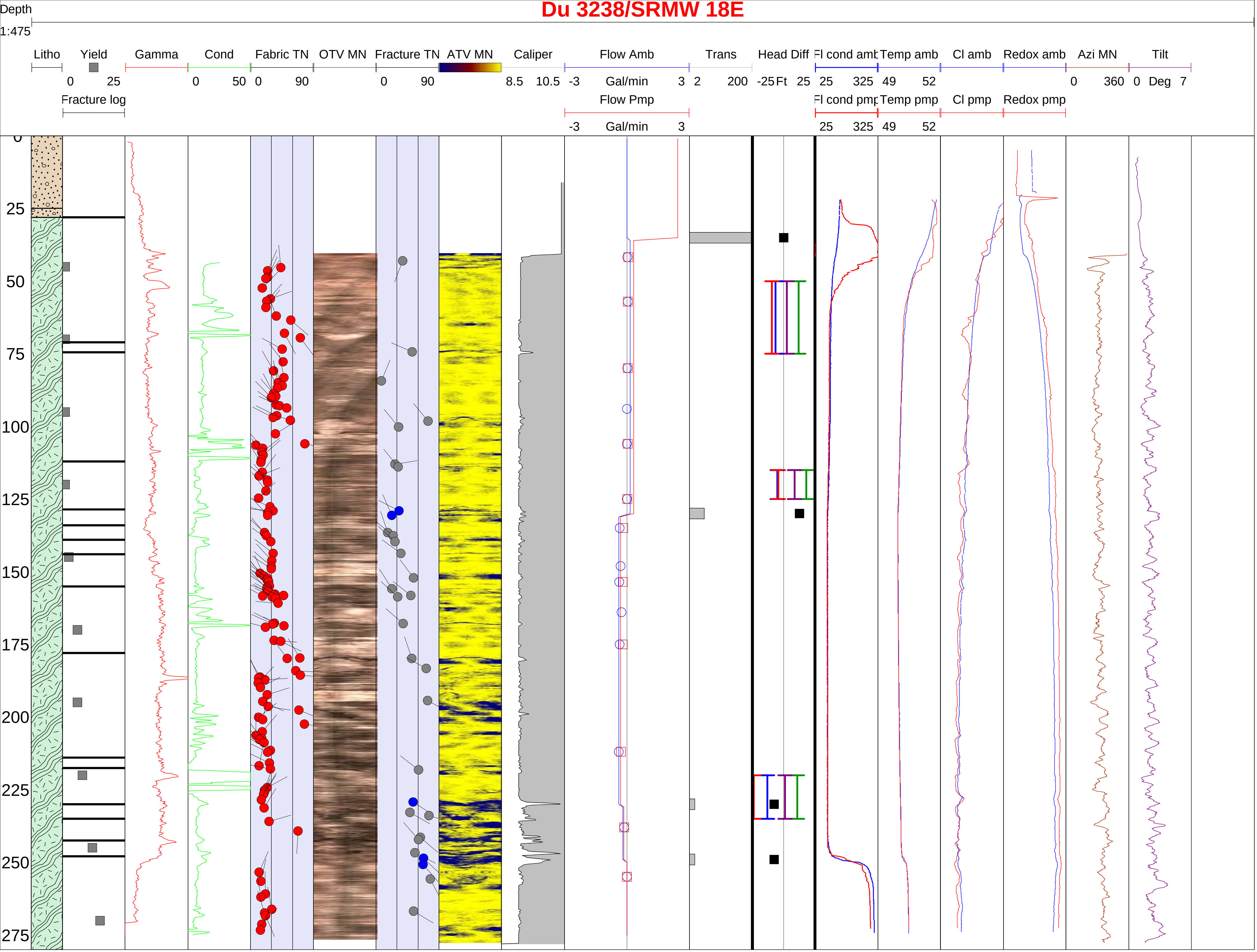
Tool run 7 Mount Sopris - HPFM, HFP2293, 11:40, log up stationary measurments, pumping heat pulse flowmeter - in hole cal check.

Tool run 8 Mount Sopris- 2IDA, 3645, 14:03, log down 10ft/min, pumping fluid temp/cond/redox/Cl/ O2 - factory calibration.

Tool run 9

Remarks Casing stickup = 1.5ft above land surface

Du 3238/SRMW 18E



BOREHOLE GEOPHYSICAL LOG

English/Metric units E

SiteID (C1) 413136073473502	**Station name (C12)** Du 3240	**Other ID** SRMW-18F	**Log date** 3/15/2007
County Dutchess	**State** New York	**Project** CCW00	**Recorded by** JAA
Observed by RJR			
Location description	**Owner** Ground Water Sciences		
Latitude 41 31 36.0	**Longitude** 073 47 35.2	**Lat/Long datum** NAD83	**Log measurement point (LMP)** LS
Height LMP 0.0	**Altitude LMP** 505.03	**Altitude datum** NGVD29	**Description of LMP** Land surface
Borehole depth 501	**Borehole diameter** 6	**Casing bottom** 321	**Casing diameter** 6
Casing type steel			
Source of data USGS	**Logging unit** Troy	**Log orientiation** MN	**Magnetic declination** -13.5
Software non-ASCII logs	**Fluid type** water	**Fluid depth below LMP** 35.70	**at time** 17:38
Hydrologic conditions ambient, pump 1.3 gal/min, start pump at 17:43 stop pump at 19:26, drawdown= 0.97ft:	**Type of log** ZZ		

Tool manufacturer and model, tool serial number, log date and time, logging direction and speed, depth error after logging, log parameter(s) and date(s) of calibration check

Tool run 1 Century 9065, 715, 2/22/2007 - 08:53, log up 15ft/min, depth error= 0, well diameter in inches - in hole cal check.

Tool run 2 Century 9042-858, 2/22/2007 - 09:24, log down 15 ft/min, depth error= 0.03ft, gamma and ambient fluid cond and temp.

Tool run 3 Century 9510-746, 2/22/2007 -09:22, log up 15 ft/min, depth error= 0.3ft, gamma and formation conductivity.

Tool run 4 Mount Sopris -OBI-40, 000603, 2/22/2007 -13:44, log up 4 ft/min, depth error= 0.2ft, optical image and deviation- in hole cal check

Tool run 5 Mount Sopris - 2PMA, 2/22/2007 -14:33, log up 15 ft/min, depth error = -0.46ft, magnetic susceptibility, free air cal check.

Tool run 6 Mount Sopris - HPFM, HFP2060, 16:18, log down stationary measurments, ambient heat pulse flowmeter

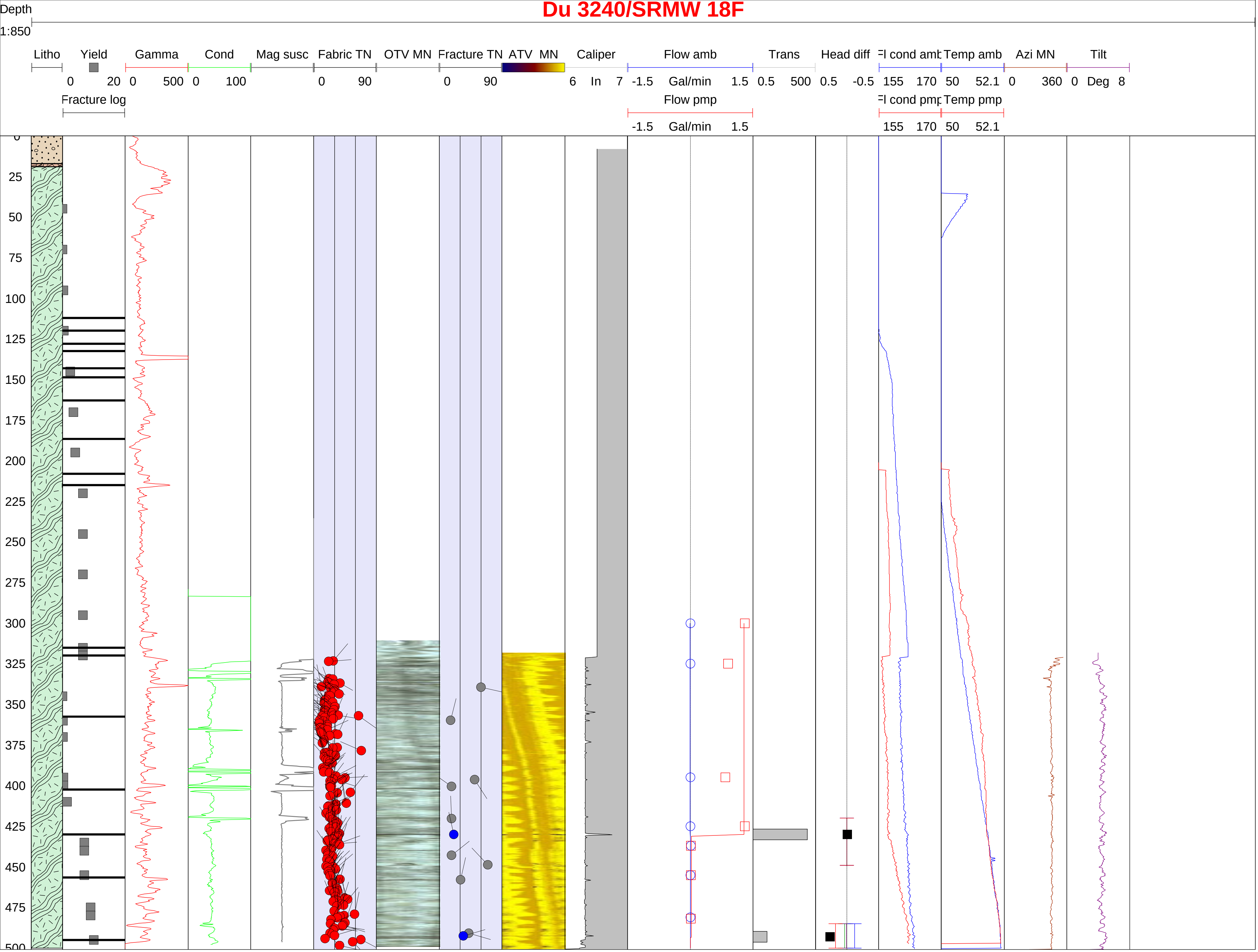
Tool run 7 Mount Sopris - HPFM, HFP2060, 18:02, log up stationary measurments, pumping heat pulse flowmeter - in hole cal check.

Tool run 8 Century 9042-858,19:11, log down 15 ft/min, gamma and pumping fluid cond and temp.

Tool run 9

Remarks Casing stickup = 3.4ft

Du 3240/SRMW 18F



BOREHOLE GEOPHYSICAL LOG

English/Metric units E

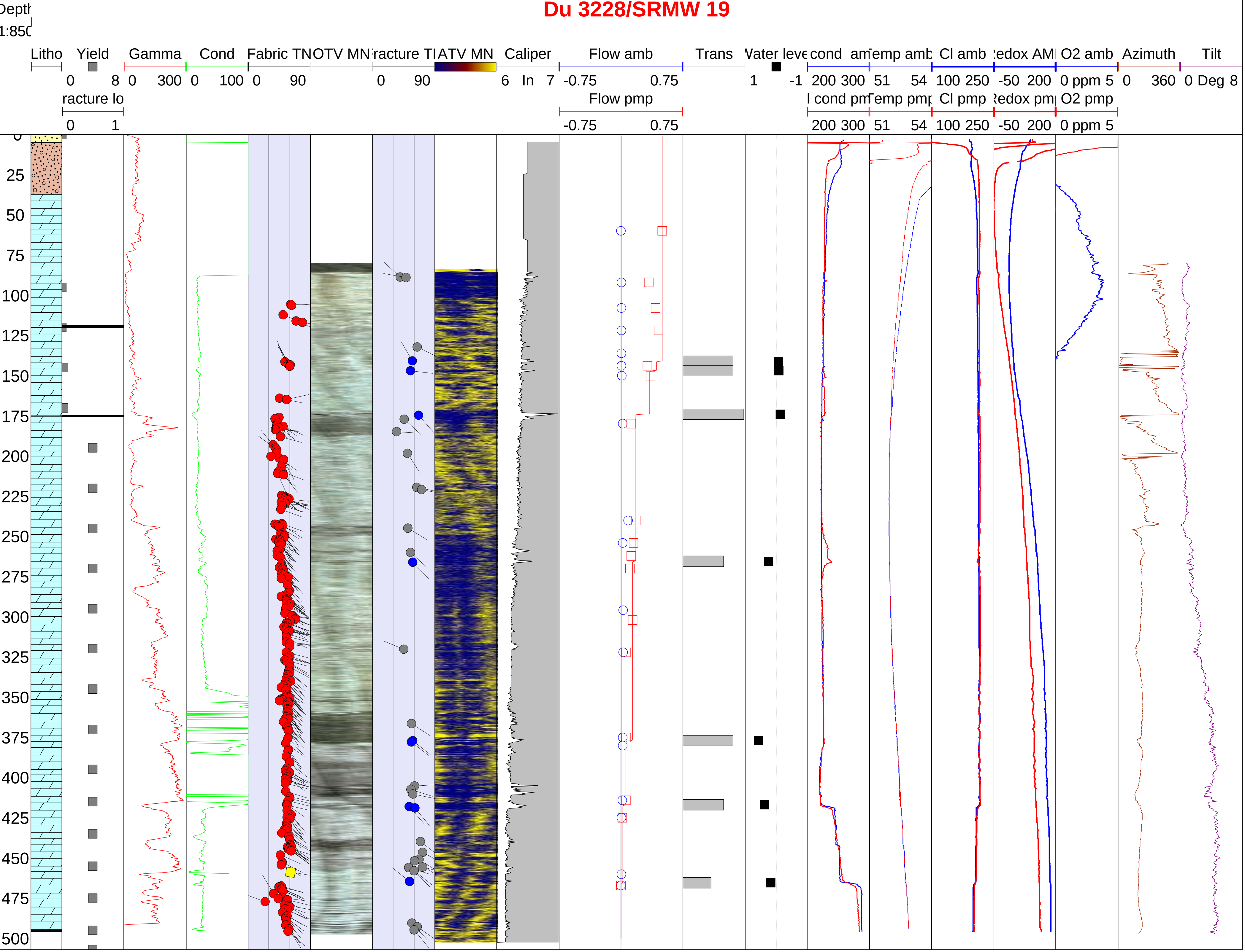
SiteID (C1) 413133073471201	**Station name (C12)** Du 3228	**Other ID** SMRW-19		**Log date** 11/16/2006
County Dutchess	**State** New York	**Project** CCW00	**Recorded by** JAA	**Observed by** MJS
Location description			**Owner** Ground Water Sciences	
Latitude 41 31 33.2	**Longitude** 073 47 12.1	**Lat/Long datum** NAD83	**Log measurement point (LMP)** LS	
Height LMP 0.0	**Altitude LMP** 322.69	**Altitude datum** NGVD29	**Description of LMP** Land surface	
Borehole depth 500	**Borehole diameter** 6	**Casing bottom** 86	**Casing diameter** 6	**Casing type** steel
Source of data USGS	**Logging unit** Troy	**Log orientiation** MN	**Magnetic declination** -13.5	
Software non-ASCII logs	**Fluid type** water	**Fluid depth below LMP** 0.95	**at time** 11:02	
Hydrologic conditions ambient, pump 0.5 gal/min, start pump at 11:15 stop pump at 13:34, drawdown= 5.17ft		**Type of log** ZZ		

Tool manufacturer and model, tool serial number, log date and time, logging direction and speed, depth error after logging, log parameter(s) and date(s) of calibration check

Tool run 1	Century 9065, 574,11/15/2006 - 10:50, log up 25ft/min, depth error= 0.0ft, wellbore diameter in inches - in hole cal check.
Tool run 2	Century 9510-746,11/15/2006 - 11:45, log up 25 ft/min, depth error= -0.14ft, gamma in CPS and formation conductivity in uS/m- free air conductivity cal check at surface.
Tool run 3	Century 9800-1106, 11/15/2006 - 13:03, log up 10 ft/min, depth error= 0.0ft, acoustic image and wellbore deviation- in hole cal check.
Tool run 4	Mount Sopris OBI-40 -000603, 11/15/2006 - 15:30, log up 4 ft/min, depth error= 0.18ft, optical image and wellbore deviation- in hole cal check
Tool run 5	Mount Sopris 2IDA - 3645, 07:00, log down 10ft/min, ambient fluid temp/cond/redox/Cl/ O2 - factory calibration.
Tool run 6	Mount Sopris - HPFM, HFP2060, 08:50, log down stationary measurments, ambient heat pulse flowmeter - in hole cal check.
Tool run 7	Mount Sopris - HPFM, HFP2060, 11:46, log up stationary measurments, depth correction= 0.0ft, pumping heat pulse flowmeter - in hole cal check.
Tool run 8	Mount Sopris 2IDA - 3645, 14:30, log down 10ft/min, pumping fluid temp/cond/redox/Cl/ O2 - factory calibration.
Tool run 9	

Remarks Casing stickup = 3.0ft ablve land surface

Du 3228/SRMW 19



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BOREHOLE GEOPHYSICAL LOG

English/Metric units E

SiteID (C1) 413117073472601
Station name (C12) Du 3229
Other ID SRMW-20
Log date 11/17/2006

County Dutchess
State New York
Project CCW00
Recorded by JAA
Observed by RJR

Location description
Owner Ground Water Sciences

Latitude 41 31 17.1
Longitude 073 47 26.8
Lat/Long datum NAD83
Log measurement point (LMP) LS

Height LMP 0.0
Altitude LMP 341.96
Altitude datum NGVD29
Description of LMP Land surface

Borehole depth 320
Borehole diameter 6
Casing bottom 36.4
Casing diameter 6
Casing type steel

Source of data USGS
Logging unit Troy
Log orientiation MN
Magnetic declination -13.5

Software non-ASCII logs
Fluid type water
Fluid depth below LMP flowing
at time

Hydrologic conditions Well flowing at 60+/- gal/min.
Type of log ZZ

Tool manufacturer and model, tool serial number, log date and time, logging direction and speed, depth error after logging, log parameter(s) and date(s) of calibration check

Tool run 1 Century 9042-858, 09:02, log down 20 ft/min, depth error= 0.18 ft, gamma and ambient fluid temp in deg F and cond in uS/cm- fluid temp and cond in hole cal check.

Tool run 2 Century 9800-1106, 10:02, log up 10 ft/min, depth error= 0.0ft, acoustic image and deviation- in hole cal check.

Tool run 3 Century 9721-1162, stationary , 10:46, depth error= 0.0ft, ambient wellbore flow in gal/min -in hole cal check

Tool run 4 Century 9510-746, 12:09, log up 20 ft/min, depth error= 0.0ft, gamma in CPS and formation conductivity in uS/m- free air conductivity cal check at surface.

Tool run 5

Tool run 6

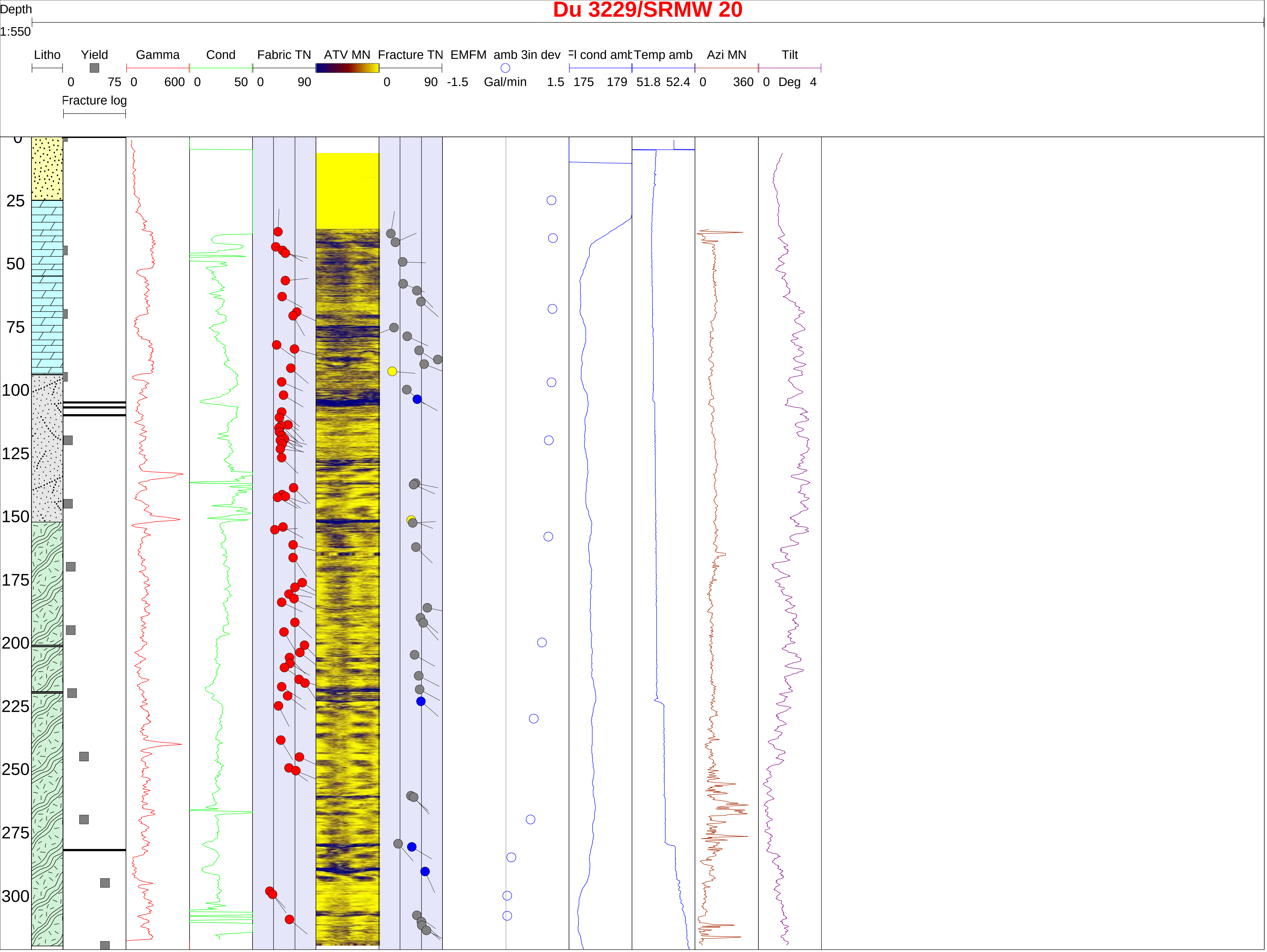
Tool run 7

Tool run 8

Tool run 9

Remarks Casing stickup = 3.0 ft above land surface.

Du 3229/SRMW 20



A-2: Residential Well Physical Data

- A-2a: Converted Residential Well Physical Database
- A-2b: Converted Residential Well Logs
- A-2c: Converted Residential Well USGS Geophysical Logs
- A-2d: Lithologic Interpretations

A-2a: Converted Residential Well Physical Database

Appendix A-1: Residential Well Physical Data
Shenandoah Road RI/FS

Well Number	*Lithology Interpretation*	*Elevation Grade (ft amsl)*	*Lithology Interval (feet bgs)*	*Lithology Interval (feet amsl)*	*Elevation TOC (ft amsl)*	*Reconstructed Well ID*	*Construction Notes*	*WBZ ID*	*WBZ Info (ft bgs)*	*WBZ Info (ft amsl)*	*Transmissivity ft^2 / day*
BRB003	gneiss	440	18.5 - 260	421.5 - 180	441.00		open hole	1	24	416	1.25
	fracture zone	440	260 - 275	180 - 165		BRB003	open hole	2 +	263	177	30
BRB005	gneiss	450	20 - 275	430 - 175	450.50		not used	1	36	414	12.5
						BRB005-S	annular space	2	86	364	3.37
						BRB005-D	2-inch piez	3	242	208	9.37
							monitors WBZ 3 & 4	4	259	191	12.50
BRB006	gneiss	375	39.5 - 235	335.5 - 140	376.00	BRB006-S	annular space	1	78	297	16.4
							cased off	2	146	229	16.4
						BRB006-D	2-inch piez	3	211	164	16.4
							monitors WBZ 3 & 4	4	230	145	16.4
BRB007	gneiss	425	51.5 - 230	373.5 - 195	426.00	BRB007-S	annular space	1	35	390	28.5
						BRB007-D	2-inch piez	2	91	334	8.5
							sealed off	3	221	204	21.0
BRB009	gneiss	450	18.5 - 300	431.5 - 150	451.20	BRB009-S	open hole	1	31	419	0.125
								2	112	338	1.5
						BRB009-D	open hole	3	290	160	1.0
BRB011	gneiss	435	31.5 - 215	403.5 - 220	436.20	BRB011-S	annular space	1	31	404	1.25
						BRB011-D	2-inch piez	2	208	226.7	3.80
BRB014	gneiss	368	31 - 199	337 - 169	368.80	BRB014	mimic domestic		31	337	1.75
							open hole		73	295	2
									195	173	35.5
EHC002	gneiss	390	27 - 277	363 - 113	391.30	EHC002-S	passive, annular space	1	44	346	4
			-			EHC002-M	passive, annular space	2	154	236	13.2
						EHC002-D	2-inch piez	3	275	115	0.1
EHC009	gneiss	484	unknown - 144.9	unknown - 339.1	486.35	EHC009	mimic domestic open hole		Not applicable	Not applicable	Not Measured
EHC017	gneiss	515	unknown - 90	unknown - 425	515.90	EHC017	mimic domestic open hole		Not applicable	Not applicable	Not Measured
GRF006	quartzite	341	35 - 275	306 - 66	341.34	GRF006	mimic domestic	1	40	311	Not Available
	carbonate	341	275 - 520	66 - -179			open hole	2	508	-157	Not Available
	quartzite	341	520 - 640	-179 - -299							
GRF007	shale (carbonate)	351	22.5 - 40	328.5 - 311	351.00	GRF007	mimic domestic	1	40	311	2.50
	carbonate	351	40 - 91	311 - 260			open hole	2	58	293	0.08
GRF007 Deep	quartzite	351	35 - 245	316 - 106	351.00	GRF007 Deep	mimic domestic	1	36	315	Not Available
	carbonate	351	245 - 385	106 - -34			open hole	2	245	106	Not Available
JCK117	carbonate	320	60 - 172	260 - 148	322.00	JCK117	mimic domestic	1	70	250	0.65
	shale (carbonate)	320	172 - 275	148 - 45			open hole	2	215	105	0.50
	carbonate	320	275 - 360	45 - -40				3	518	-198	0.70
	shale (carbonate)	320	360 - 490	-40 - -170							
	carbonate	320	490 - 500	-170 - -180							
	shale (carbonate)	320	500 - 520	-180 - -200							
OTN007	carbonate	337.9	60 - 323	277.9 - 14.9	339.17	OTN007	mimic domestic	1	294	57	Not Available
	carbonate						open hole				
SEY004	gneiss	360	36 - 159	324 - 201	361.20	SEY004	mimic domestic		32	328	0.5
							open hole		38	322	0.5
									153	207	75
SEY005	shale	345	51.5 - 145	293.5 - 200	346.20	SEY005-S	annular space	1	53	292	0.75
	gneiss	345	95 - 322	250 23		SEY005-D	2-inch piez	2	320	25	55
SEY006	gneiss	365	31 - 220	334 - 145	365.85	SEY006	mimic domestic		199	166	55
							open hole		203	162	31.9
									215	150	9.9
SEY007	shale (carbonate)	345	42.5 - 118	302.5 - 227	346.90	SEY007-S	annular space	1	45	300	60
						SEY007-D	2-inch piez	2	114	231	5
SHN472	quartzite	340	5 - 85	335 - 255	351.33	SHN472	mimic domestic open hole		Not applicable	Not applicable	Not Measured
CHN472	quartzite		8 - 38	-	332.70	CHN472	mimic domestic open hole		Not applicable	Not applicable	Not Measured
SHN466	quartzite	333.55	105 - 330	228.55 - 3.55	334.35	SHN466	mimic domestic	1	105	246	Not Available
	shale (carbonate)	333.55	330 - 483	3.55 - -149.45			open hole	2	357	-6	Not Available
				-				3	466	-115	Not Available
SHN478	quartzite	355.06	5 - 105	350 - 250	357.36	SHN478-S	annular space	1	62	293.06	385
								2	69	286.06	15
						SHN478-D	2-inch piez	3	103	252.06	7
SHN499	gneiss	405	24 - 140	381 - 265	406.70	SHN499-S	annular space	1	85	320	Not Reported
						SHN499-D	2-inch piez	2	144	261	Not Reported
SHN589	gneiss	360	19.5 - 190	340.5 - 170	361.60	SHN589	mimic domestic		24	336	1.25
							open hole		167	193	257
SHN591	gneiss	355	33 - 154	322 - 201	356.10	Not Used	Not Used		138	217	62.5
SHN603	gneiss	348	24.5 - 240	323.5 - 108	349.20	SHN603	open hole	1	244	104	48
STN051	gneiss	535	19.5 - 205	515.5 - 330	536.35	STN051-S	temp packer, 0-184	1	107	428	41
						STN051-D	temp packer, 194-213.5	2	205	330	80
TWN134	carbonate	285	49.5 - 115	235.5 - 170	286.10	TWN134	passive sampler	1	70	215	0.95
	shale (carbonate)	285	115 - 200	170 - 85				2	265	20	1.9
	shale (carbonate)	285	200 - 270	85 - 15			passive sampler	3	270	15	4.75
	quartzite	285	270 - 340	15 - -55			passive sampler	4	288	-3	6.75
							passive sampler	5	320	-35	19

A-2b: Converted Residential Well Logs

GROUNDWATER SCIENCES CORPORATION

GEOLOGIC LOG: BRB003

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PROJECT INFORMATION		DRILLING INFORMATION	
PROJECT:	***Shenandoah Road Residential Wells***	DRILLING CO.:	***Unknown***
SITE LOCATION:	***Town of East Fishkill, Dutchess Co., NY***	DRILLER:	***Unknown***
JOB NO.:	***01003.11.0114***	RIG TYPE:	***Unknown***
LOGGED BY:	***Lithology based on interpretation of USGS Geophysical Log***	DRILLING METHOD:	***Unknown***
DATES DRILLED:	***Unknown***	DEVELOPMENT DATE:	***Unknown***
		LOCATION:	***3 Burbank Road, behind house near pool***

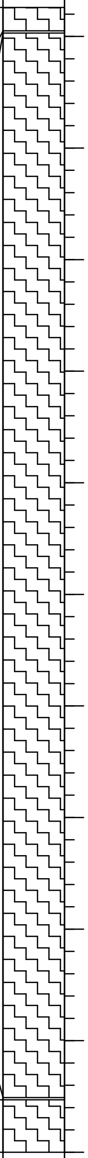
NOTES: TOC Elevation: 441.00 ft amsl

SURFACE ELEVATION: 440 ft amsl

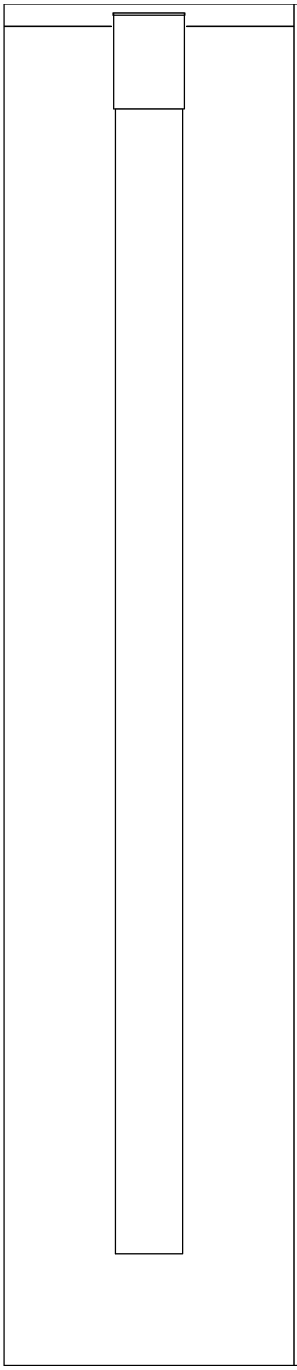
NORTHING: To Be Determined EASTING: To Be Determined

DEPTH FEET	CUM. BLOWN YIELD	VOC (ppm)	LITHOLOGY	DEPTH FEET	WELL CONSTRUCTION DETAILS
0	NA			0	6" locking well cap 6" dia. steel casing +1.0' to 18.5'
25			GNEISS WATERBEARING ZONE: 24 ft GNEISS	25	
50				50	
75				75	
100	NA			100	
125				125	
150				150	6" dia. borehole, 18.5' to 275'
175				175	
200	NA			200	
225				225	
250			WATERBEARING ZONE: 263 ft GNEISS: Fracture zone 260 to 275 ft	250	
275	NA			275	
300				300	

GRAPHIC



WELL CONSTRUCTION



GROUNDWATER SCIENCES CORPORATION

GEOLOGIC LOG: BRB005D/S

Page 1 of 1

PROJECT INFORMATION

PROJECT: *Shenandoah Road Residential Well Construction*

SITE LOCATION: *Town of East Fishkill, Dutchess Co., NY*

JOB NO.: *01003.11.0105*

LOGGED BY: *Lithology based on interpretation of USGS Geophysical Log*

DATES DRILLED: *Unknown*

DRILLING INFORMATION

DRILLING CO.: *Unknown*

DRILLER: *Unknown*

RIG TYPE: *Unknown*

DRILLING METHOD: *Unknown*

DEVELOPMENT DATE: *Unknown*

LOCATION: *5 Burbank Road, behind house in woods*

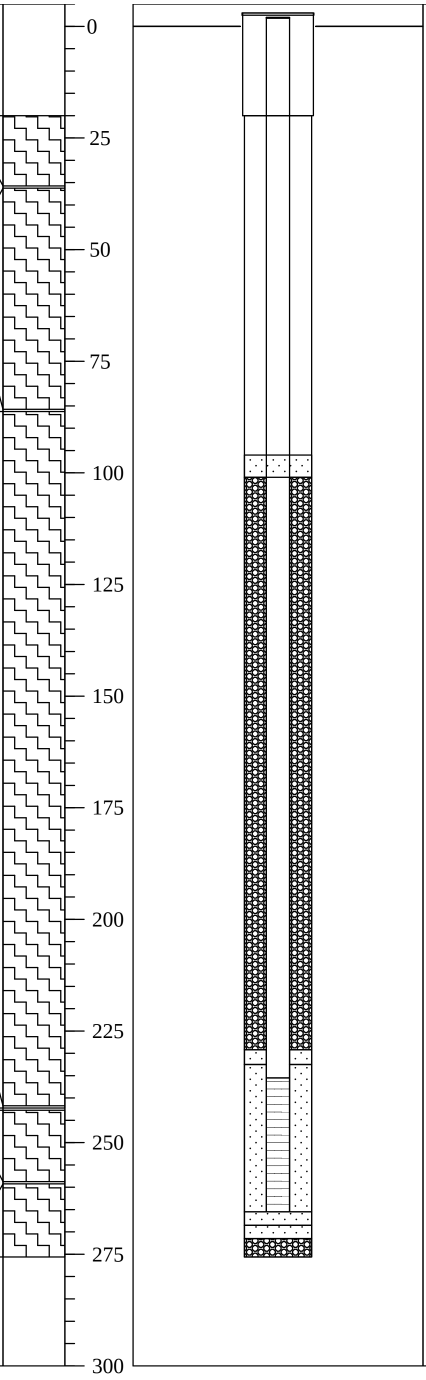
NOTES: SWL (3/30/2011): BRB005D 12.92/BRB005S 21.29 ft. below TOC
TOC Elevation: 450.14 / 450.50 ft amsl
Well construction completed on 2/24/2011 by MWR

SURFACE ELEVATION: 450 ft amsl

NORTHING: To Be Determined EASTING: To Be Determined

DEPTH FEET	CUM. BLOWN YIELD	VOC (ppm)	LITHOLOGY
0	NA		
25			GNEISS
			WATERBEARING ZONE: 36 ft
			GNEISS
50			
75			
			WATERBEARING ZONE: 86 ft
			GNEISS
100	NA		
125			
150			
175			
200	NA		
225			
			WATERBEARING ZONE: 242 ft
			GNEISS
250			
			WATERBEARING ZONE: 259 ft
			GNEISS
275	NA		
300			

GRAPHIC



WELL CONSTRUCTION DETAILS

6" locking well cap

6" dia. steel casing +0.5' to 20'

Open annulus is BRB005S

2" dia. PVC casing +0.1' to 235.5'

Open 2x6 annulus, 0 to 96'

#3 and #4 grade choke sand, 96' to 101'

2" dia. PVC casing +2' to 235.5'

Bentonite chip 6"x2" annular seal, 101' to 229.2'

Screened interval is BRB005D

#3 and #4 grade choke sand, 229.2' to 232.5'

2 grade sand pack, 232.5' to 268.5'

2" dia. 30 Slot PVC screen 235.5' to 265.5'

#3 and #4 grade choke sand, 268.5' to 271.5'

Bentonite chip backfill, 271.5' to 275.6'

6" dia. borehole, 20' to 275.6'

GROUNDWATER SCIENCES CORPORATION

GEOLOGIC LOG: BRB006D/S

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PROJECT INFORMATION

PROJECT: ***Shenandoah Road Residential Well Construction***

SITE LOCATION: ***Town of East Fishkill, Dutchess Co., NY***

JOB NO.: ***01003.11.0105***

LOGGED BY: ***Lithology based on interpretation of USGS Geophysical Log***

DATES DRILLED: ***Unknown***

DRILLING INFORMATION

DRILLING CO.: ***Unknown***

DRILLER: ***Unknown***

RIG TYPE: ***Unknown***

DRILLING METHOD: ***Unknown***

DEVELOPMENT DATE: ***Unknown***

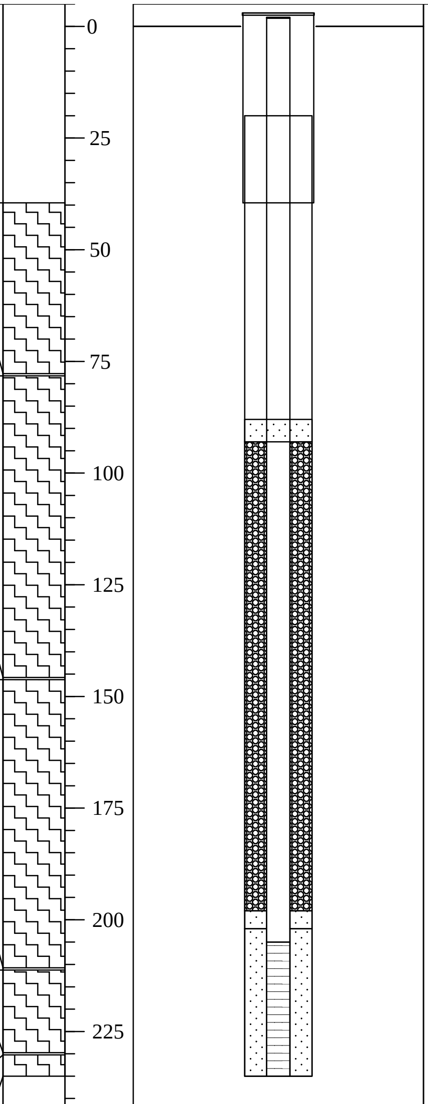
LOCATION: ***6 Burbank Road, right side of house in open lawn***

NOTES: SWL (3/10/2011): BRB006D 16.90/BRB006S 13.73 ft. below TOC
TOC Elevation: 375.85 / 376.00 ft amsl
Well construction completed on 11/26/2010 by MWR

SURFACE ELEVATION: 375 ft amsl

NORTHING: To Be Determined EASTING: To Be Determined

DEPTH FEET	CUM. BLOWN YIELD	VOC (ppm)	LITHOLOGY
0	NA		
25			
			GNEISS
50			
			WATERBEARING ZONE: 78 ft
75			GNEISS
100	NA		
125			
			WATERBEARING ZONE: 146 ft
150			GNEISS
175			
200	NA		
			WATERBEARING ZONE: 211 ft
			GNEISS
225			WATERBEARING ZONE: 230 ft
	NA		GNEISS
250			
275			
300			



WELL CONSTRUCTION DETAILS

6" locking well cap

6" dia. steel casing +1 to 39.5'

Open annulus is BRB006S

2" dia. PVC casing +0.8' to 250'

Open 2x6 annulus, 0 to 88'

#3 and #4 grade choke sand, 88' to 93'

Bentonite chip 6"x2" annular seal, 93' to 198'

2" dia. PVC casing +0.8' to 205'

6" dia. borehole, 20' to 235'

#3 and #4 grade choke sand, 196' to 202'

2 grade sand pack, 202' to 235'

Screened interval is BRB006D

2" dia. 30 Slot PVC screen 205' to 235'

GROUNDWATER SCIENCES CORPORATION

GEOLOGIC LOG: BRB007D/S

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PROJECT INFORMATION

PROJECT: ***Shenandoah Road Residential Well Construction***
SITE LOCATION: ***Town of East Fishkill, Dutchess Co., NY***
JOB NO.: ***01003.11.0105***
LOGGED BY: ***Lithology based on interpretation of USGS Geophysical Log***
DATES DRILLED: ***Unknown***

DRILLING INFORMATION

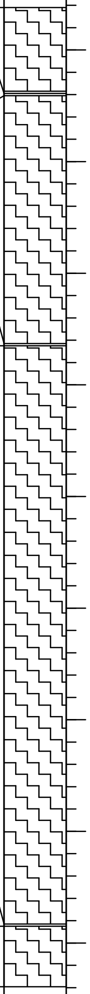
DRILLING CO.: ***Unknown***
DRILLER: ***Unknown***
RIG TYPE: ***Unknown***
DRILLING METHOD: ***Unknown***
DEVELOPMENT DATE: ***Unknown***
LOCATION: ***7 Burbank Road, behind house, on hill***

NOTES: SWL (3/10/2011): BRB007D 0.28/BRB007S 6.63 ft. below TOC
TOC Elevation: 425.72 / 426.00 ft amsl
Well construction completed on 2/11/2011 by MWR

SURFACE ELEVATION: 425 ft amsl
NORTHING: To Be Determined EASTING: To Be Determined

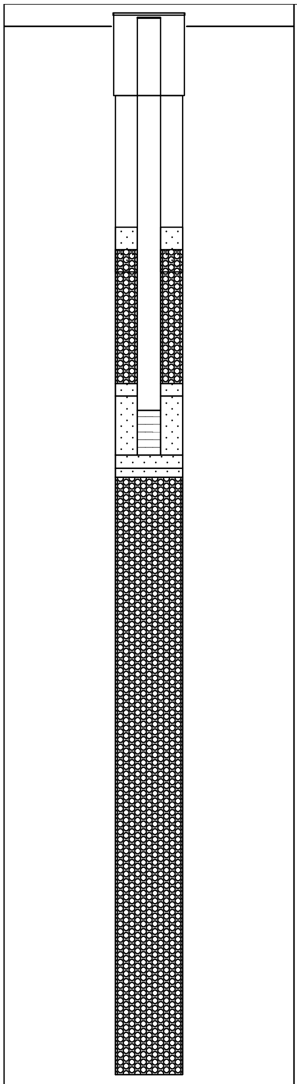
DEPTH FEET	CUM. BLOWN YIELD	VOC (ppm)	LITHOLOGY
0	NA		
			GNEISS
25			
			WATERBEARING ZONE: 35 ft
			GNEISS
50			
75			
			WATERBEARING ZONE: 91 ft
			GNEISS
100	NA		
125			
150			
175			
200	NA		
			WATERBEARING ZONE: 221 ft
225			
			GNEISS
	NA		
250			
275			
300			

GRAPHIC



DEPTH FEET: 0, 25, 50, 75, 100, 125, 150, 175, 200, 225, 250, 275, 300

WELL CONSTRUCTION



WELL CONSTRUCTION DETAILS

6" locking well cap
6" dia. steel casing +1' to 15.5'
Open annulus is BRB007S
Open 2x6 annulus, 0 to 45'
#3 and #4 grade choke sand, 45' to 50'
2" dia. PVC casing +0.7' to 86'
Bentonite chip 6"x2" annular seal, 50' to 80'
#3 and #4 grade choke sand, 80' to 82.8'
2 grade sand pack, 82.8' to 99'
2" dia. 30 Slot PVC screen 86' to 96'
#3 and #4 grade choke sand, 99' to 101'
Screened interval is BRB007D
Bentonite chip backfill, 101' to 234.8'
6" dia. borehole, 51.5' to 234.8'

GROUNDWATER SCIENCES CORPORATION

GEOLOGIC LOG: BRB009

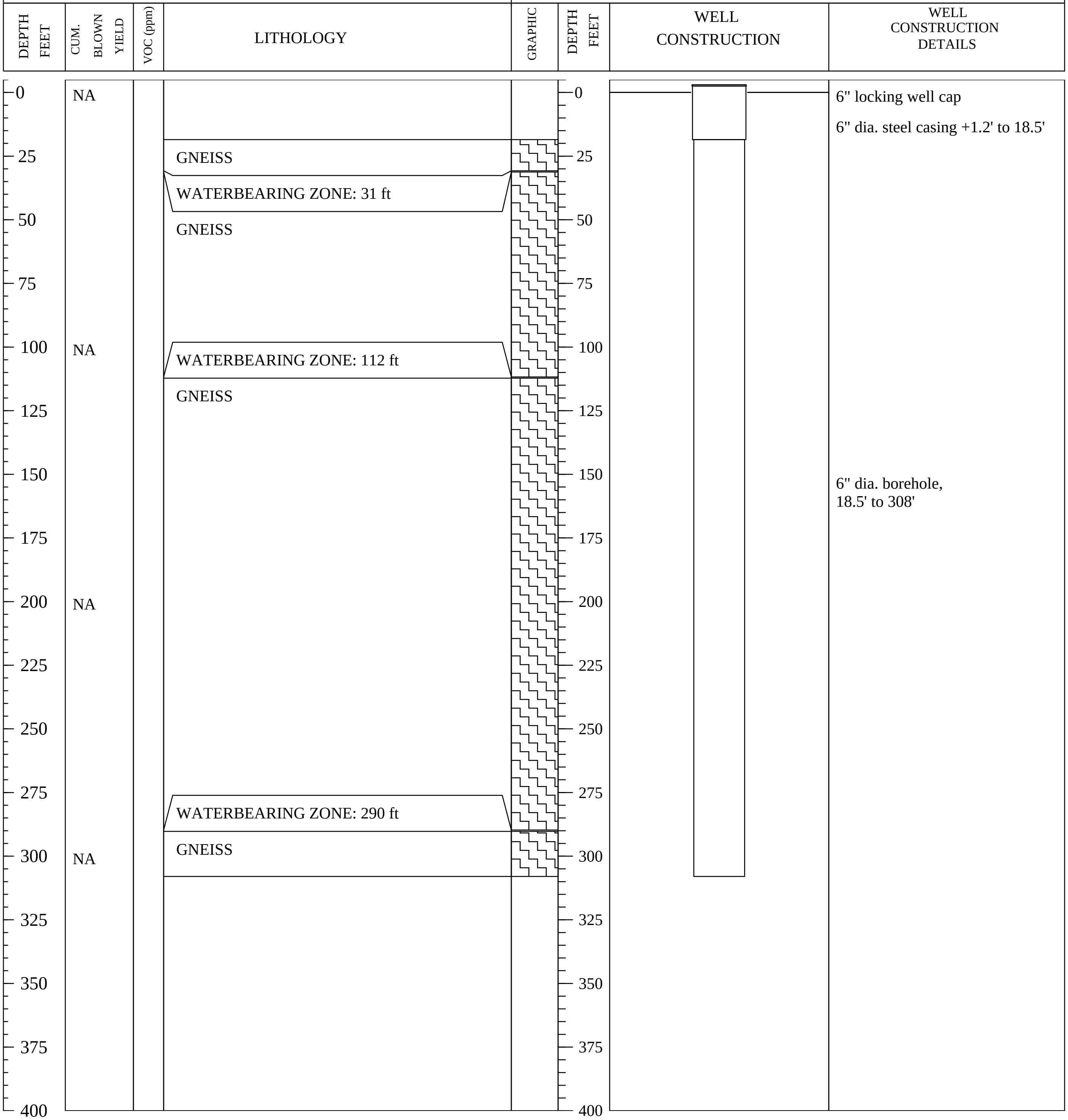
Page 1 of 1

PROJECT INFORMATION		DRILLING INFORMATION	
PROJECT:	*Shenandoah Road Residential Wells*	DRILLING CO.:	*Unknown*
SITE LOCATION:	*Town of East Fishkill, Dutchess Co., NY*	DRILLER:	*Unknown*
JOB NO.:	*01003.11.0114*	RIG TYPE:	*Unknown*
LOGGED BY:	*Lithology based on interpretation of USGS Geophysical Log*	DRILLING METHOD:	*Unknown*
DATES DRILLED:	*Unknown*	DEVELOPMENT DATE:	*Unknown*
		LOCATION:	*9 Burbank Road, behind house in woods*

NOTES:TOC Elevation: 451.20 ft amsl

SURFACE ELEVATION: 450 ft amsl

NORTHING: To Be Determined EASTING: To Be Determined



GROUNDWATER SCIENCES CORPORATION

GEOLOGIC LOG: BRB011D/S

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PROJECT INFORMATION

PROJECT: ***Shenandoah Road Residential Well Construction***

SITE LOCATION: ***Town of East Fishkill, Dutchess Co., NY***

JOB NO.: ***01003.11.0105***

LOGGED BY: ***Lithology based on interpretation of USGS Geophysical Log***

DATES DRILLED: ***Unknown***

DRILLING INFORMATION

DRILLING CO.: ***Unknown***

DRILLER: ***Unknown***

RIG TYPE: ***Unknown***

DRILLING METHOD: ***Unknown***

DEVELOPMENT DATE: ***Unknown***

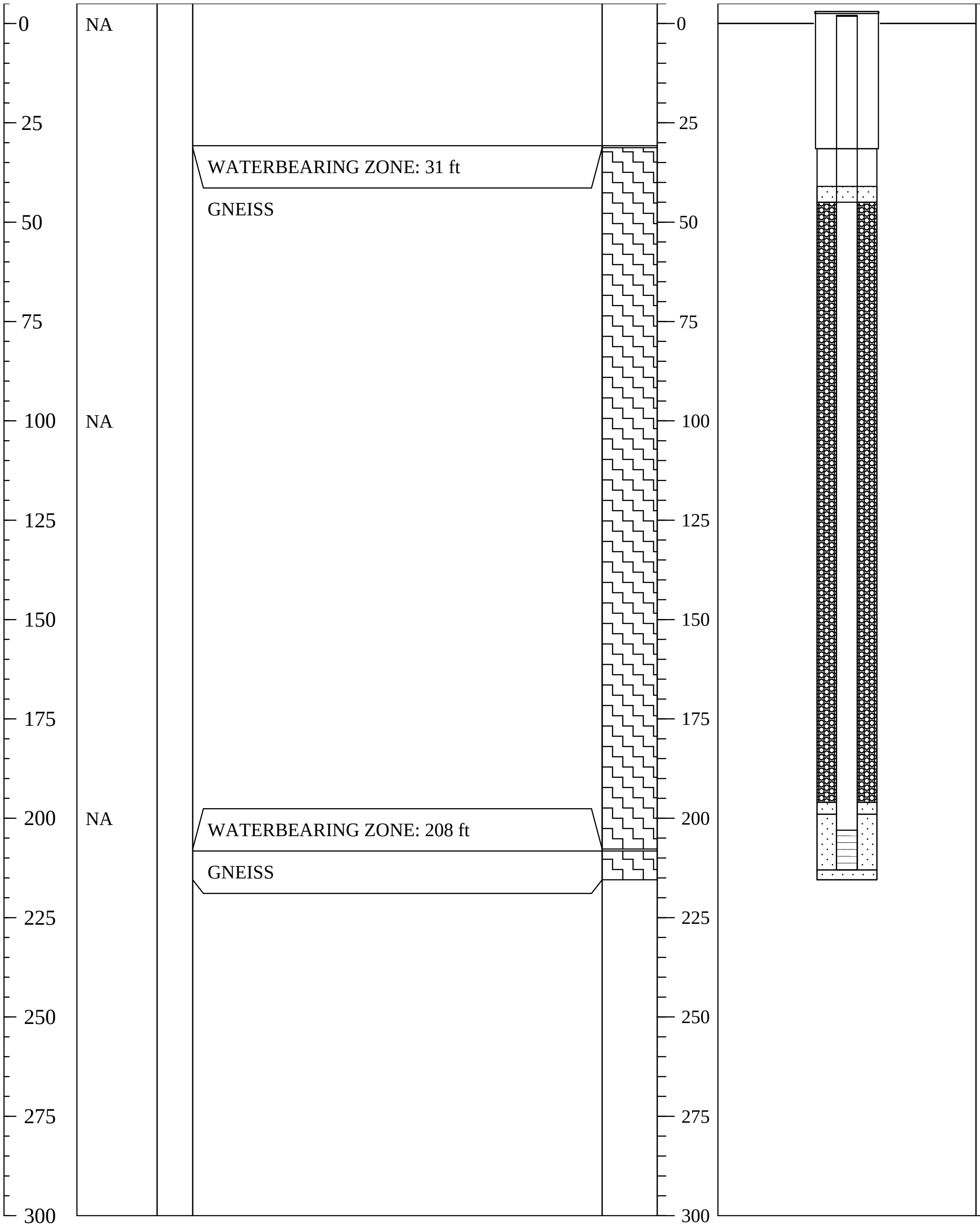
LOCATION: ***11 Burbank Road, in the middle of the back yard, on hill***

NOTES: SWL (3/10/2011): BRB011D Art./BRB011S 5.70 ft. below TOC
TOC Elevation: 436.20 / 436.20 ft amsl
Well construction completed on 11/18/2010 by MWR

SURFACE ELEVATION: 435 ft amsl

NORTHING: To Be Determined EASTING: To Be Determined

DEPTH FEET	CUM. BLOWN YIELD	VOC (ppm)	LITHOLOGY	GRAPHIC	DEPTH FEET	WELL CONSTRUCTION	WELL CONSTRUCTION DETAILS



6" locking well cap

6" dia. steel casing +1.2 to 31.5'

Open annulus is BRB011S

Open 2x6 annulus, 0 to 41'

#3 and #4 grade choke sand, 41' to 45'

Bentonite chip 6"x2" annular seal, 45' to 196'

2" dia. PVC casing +1.2' to 203'

Screened interval is BRB011D

#3 and #4 grade choke sand, 196' to 199'

2 grade sand pack, 199' to 215.5'

2" dia. 30 Slot PVC screen 203' to 213'

6" dia. borehole, 31.5' to 215.5'

GROUNDWATER SCIENCES CORPORATION

GEOLOGIC LOG: BRB014

Page 1 of 1

PROJECT INFORMATION

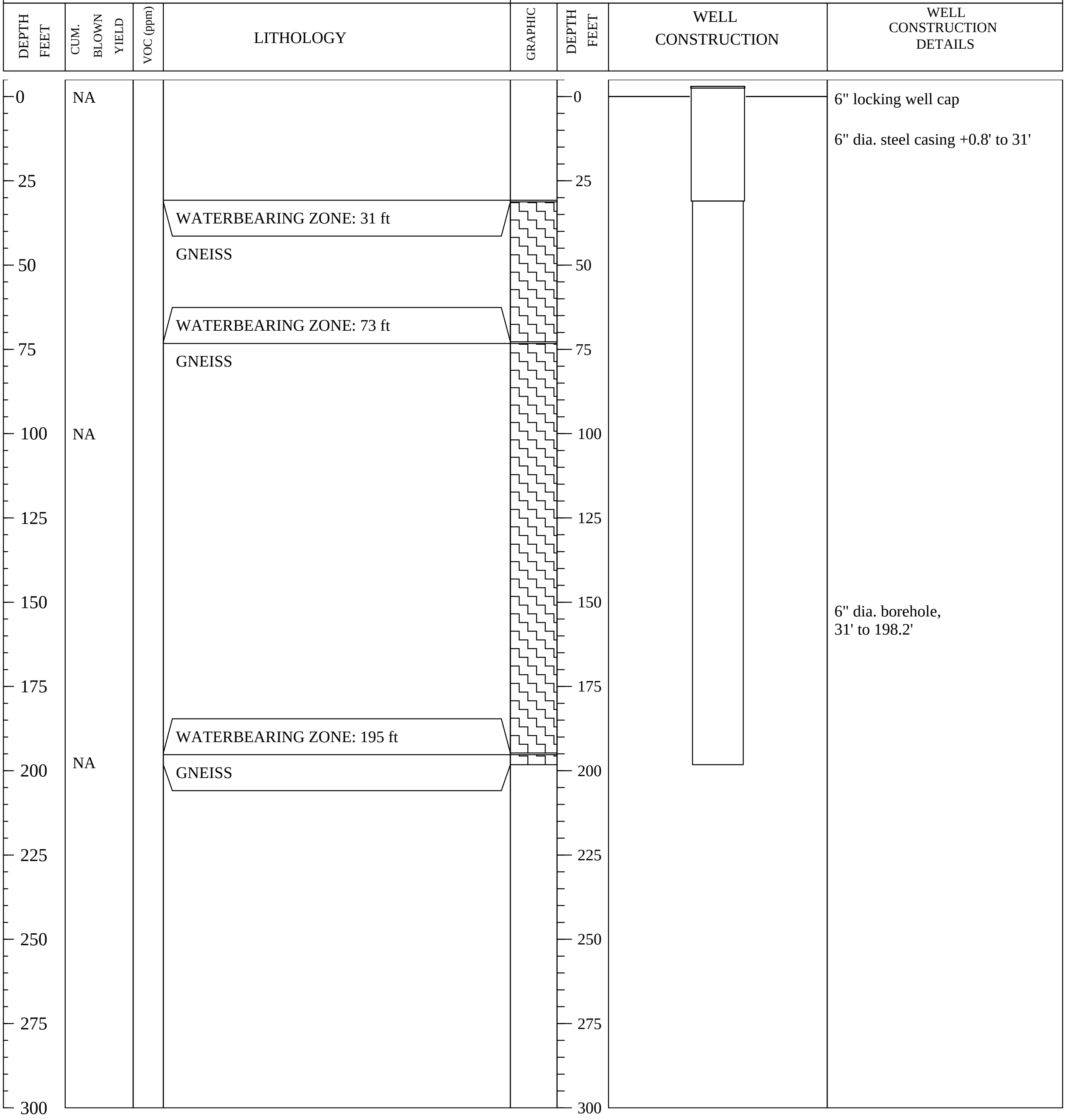
PROJECT: ***Shenandoah Road Residential Wells***
SITE LOCATION: ***Town of East Fishkill, Dutchess Co., NY***
JOB NO.: ***01003.11.0114***
LOGGED BY: ***Lithology based on interpretation of USGS Geophysical Log***
DATES DRILLED: ***Unknown***

DRILLING INFORMATION

DRILLING CO.: ***Unknown***
DRILLER: ***Unknown***
RIG TYPE: ***Unknown***
DRILLING METHOD: ***Unknown***
DEVELOPMENT DATE: ***Unknown***
LOCATION: ***14 Burbank Road, to the right of the driveway in woods***

NOTES: TOC Elevation: 368.80 ft amsl

SURFACE ELEVATION: 368 ft amsl
NORTHING: To Be Determined EASTING: To Be Determined



WATERBEARING ZONE: 31 ft

GNEISS

WATERBEARING ZONE: 73 ft

GNEISS

WATERBEARING ZONE: 195 ft

GNEISS

6" locking well cap

6" dia. steel casing +0.8' to 31'

6" dia. borehole,
31' to 198.2'

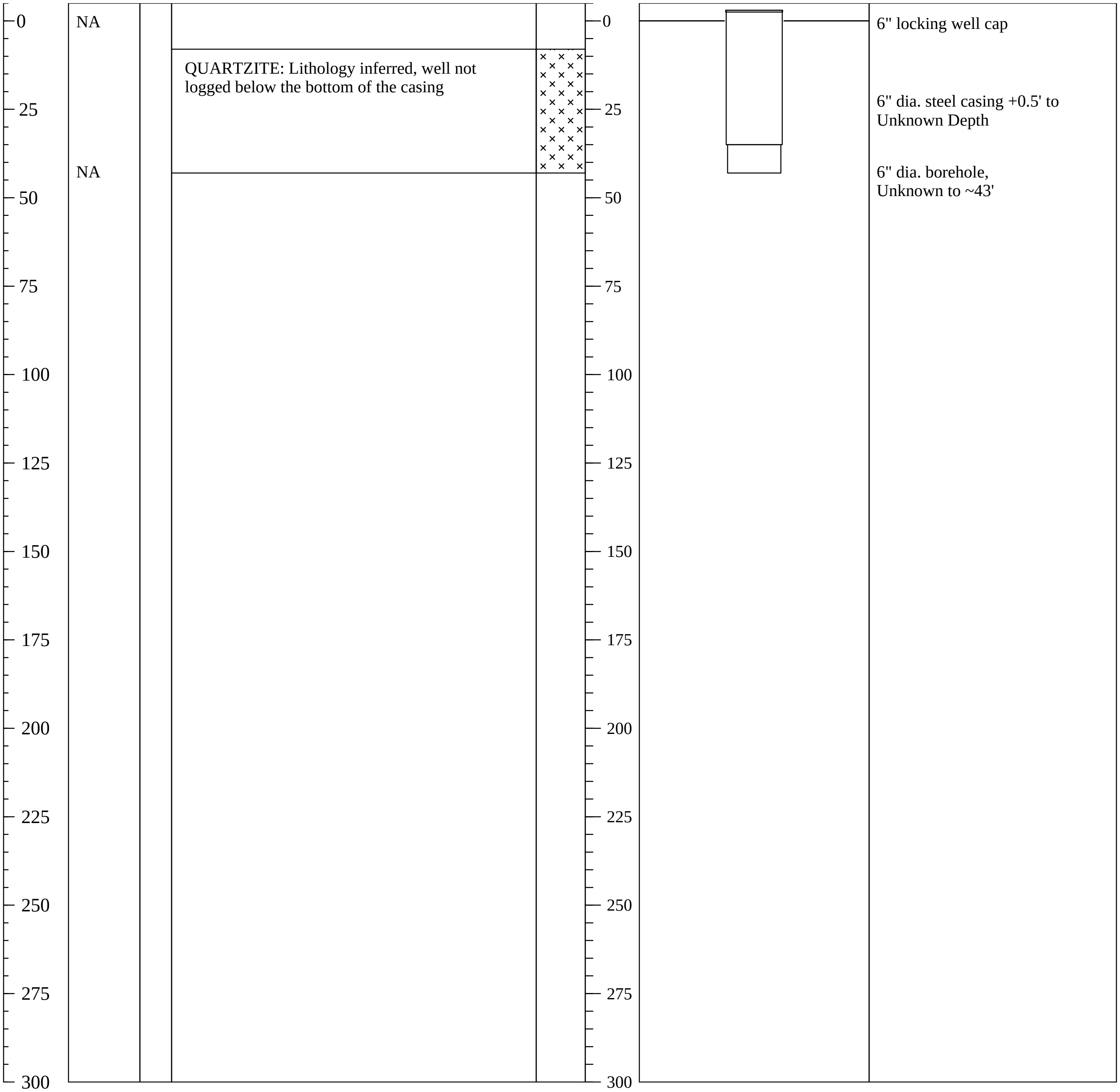
GROUNDWATER SCIENCES CORPORATION

GEOLOGIC LOG: CHN472

Page 1 of 1

PROJECT INFORMATION		DRILLING INFORMATION	
PROJECT:	***Shenandoah Road Residential Wells***	DRILLING CO.:	***Unknown***
SITE LOCATION:	***Town of East Fishkill, Dutchess Co., NY***	DRILLER:	***Unknown***
JOB NO.:	***01003.11.0114***	RIG TYPE:	***Unknown***
LOGGED BY:	***Lithology based on interpretation of USGS Geophysical Log***	DRILLING METHOD:	***Unknown***
		DEVELOPMENT DATE:	***Unknown***
DATES DRILLED:	***Unknown***	LOCATION:	***Cottage on 472 Shenandoah Road***
NOTES:	TOC Elevation: 332.70 ft amsl	SURFACE ELEVATION:	331.5 ft amsl
		NORTHING: To Be Determined	EASTING: To Be Determined

DEPTH FEET	CUM. BLOWN YIELD	VOC (ppm)	LITHOLOGY	GRAPHIC	DEPTH FEET	WELL CONSTRUCTION	WELL CONSTRUCTION DETAILS
0	NA				0		6" locking well cap
			QUARTZITE: Lithology inferred, well not logged below the bottom of the casing				6" dia. steel casing +0.5' to Unknown Depth
	NA						6" dia. borehole, Unknown to ~43'



GROUNDWATER SCIENCES CORPORATION

GEOLOGIC LOG: EHC002D/S

PROJECT INFORMATION

PROJECT: ***Shenandoah Road Residential Well Construction***
SITE LOCATION: ***Town of East Fishkill, Dutchess Co., NY***
JOB NO.: ***01003.11.0105***
LOGGED BY: ***Lithology based on interpretation of USGS Geophysical Log***
DATES DRILLED: ***Unknown***

DRILLING INFORMATION

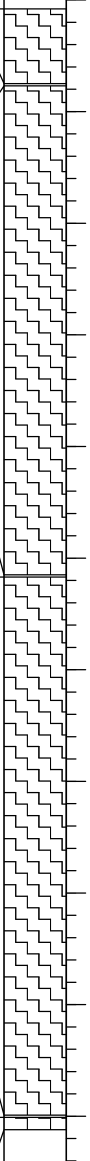
DRILLING CO.: ***Unknown***
DRILLER: ***Unknown***
RIG TYPE: ***Unknown***
DRILLING METHOD: ***Unknown***
DEVELOPMENT DATE: ***Unknown***
LOCATION: ***2 East Hook Cross Road and Shenandoah Road***

NOTES: SWL (3/11/2011): EHC002D 1.59/EHC002S 15.73 ft. below TOC
TOC Elevation: 390.98/ 391.30 ft amsl
Well construction completed 10/7/2010 by MWR

SURFACE ELEVATION: 390 ft amsl
NORTHING: To Be Determined EASTING: To Be Determined

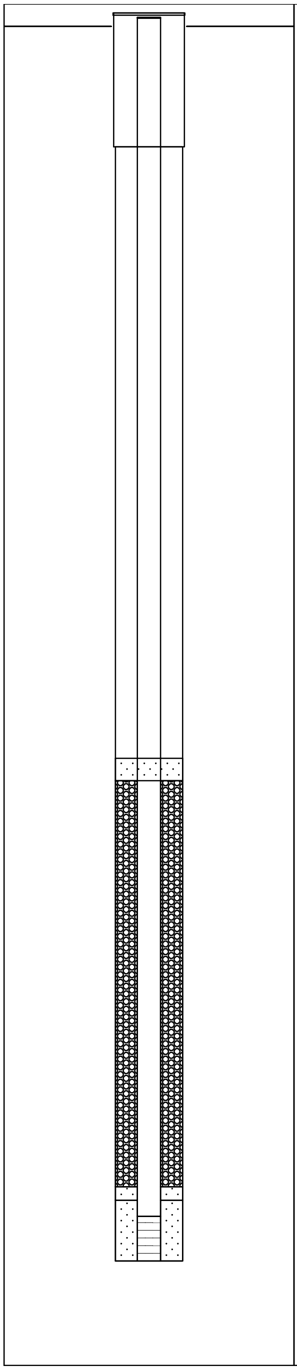
DEPTH FEET	CUM. BLOWN YIELD	VOC (ppm)	LITHOLOGY
0	NA		
25			GNEISS
			WATERBEARING ZONE: 44 ft
50			GNEISS
75			
100	NA		
125			
150			WATERBEARING ZONE: 154 ft
			GNEISS
175			
200	NA		
225			
250			
			WATERBEARING ZONE: 275 ft
275	NA		GNEISS
300			

GRAPHIC



DEPTH FEET

WELL CONSTRUCTION



WELL CONSTRUCTION DETAILS

6" locking well cap
6" dia. steel casing +1.3 to 27'
2" dia. PVC casing +1.0' to 266.6'
Open 2x6 annulus, 0 to 164'
Open annulus is EHC002S
2" dia. PVC casing +1.0' to 266.6'
#3 and #4 grade choke sand, 164' to 169'
6" dia. borehole, 27' to 276.6'
Bentonite chip 6"x2" annular seal, 169' to 260'
#3 and #4 grade choke sand, 260' to 263'
2 grade sand pack, 263' to 276.6'
2" dia. 30 Slot PVC screen 266.6' to 276.6'
Screened interval ins EHC002D

GROUNDWATER SCIENCES CORPORATION

GEOLOGIC LOG: EHC009

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PROJECT INFORMATION

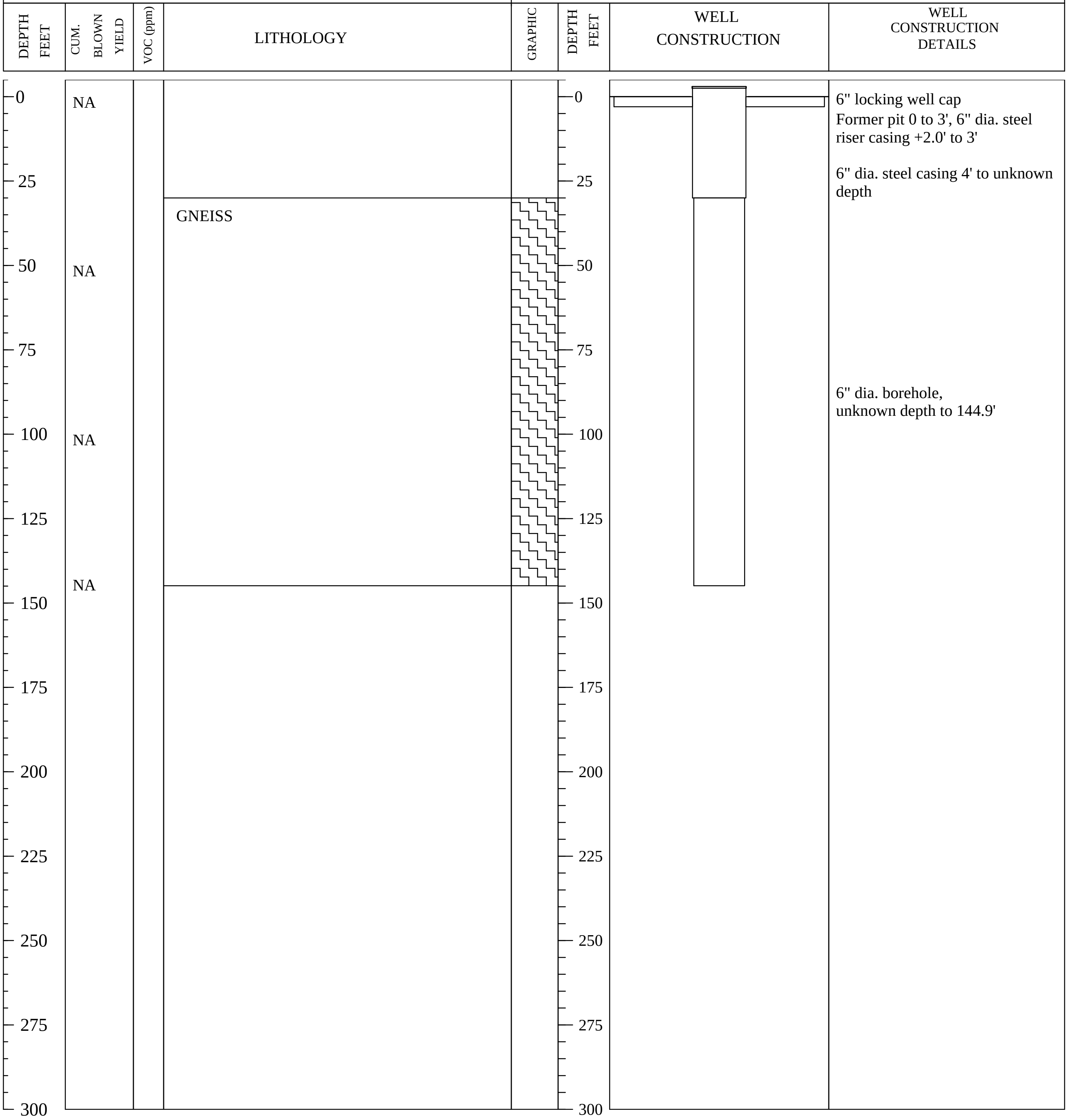
PROJECT: ***Shenandoah Road Residential Wells***
SITE LOCATION: ***Town of East Fishkill, Dutchess Co., NY***
JOB NO.: ***01003.11.0114***
LOGGED BY: ***None***
DATES DRILLED: ***Unknown***

DRILLING INFORMATION

DRILLING CO.: ***Unknown***
DRILLER: ***Unknown***
RIG TYPE: ***Unknown***
DRILLING METHOD: ***Unknown***
DEVELOPMENT DATE: ***Unknown***
LOCATION: ***9 East Hook Cross Road, side yard right side of house***

NOTES: TOC Elevation:486.35 ft amsl
Lithology based on logging of nearby wells

SURFACE ELEVATION: 484 ft amsl
NORTHING: To Be Determined EASTING: To Be Determined



GNEISS

6" locking well cap
Former pit 0 to 3', 6" dia. steel riser casing +2.0' to 3'

6" dia. steel casing 4' to unknown depth

6" dia. borehole,
unknown depth to 144.9'

GEOLOGIC LOG: EHC017

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PROJECT INFORMATION

PROJECT:	***Shenandoah Road Residential Wells***
SITE LOCATION:	***Town of East Fishkill, Dutchess Co., NY***
JOB NO.:	***01003.11.0114***
LOGGED BY:	***None***
DATES DRILLED:	***Unknown***

NOTES: TOC Elevation: 515.90 ft amsl
Lithology based on logging of nearby wells

DRILLING INFORMATION

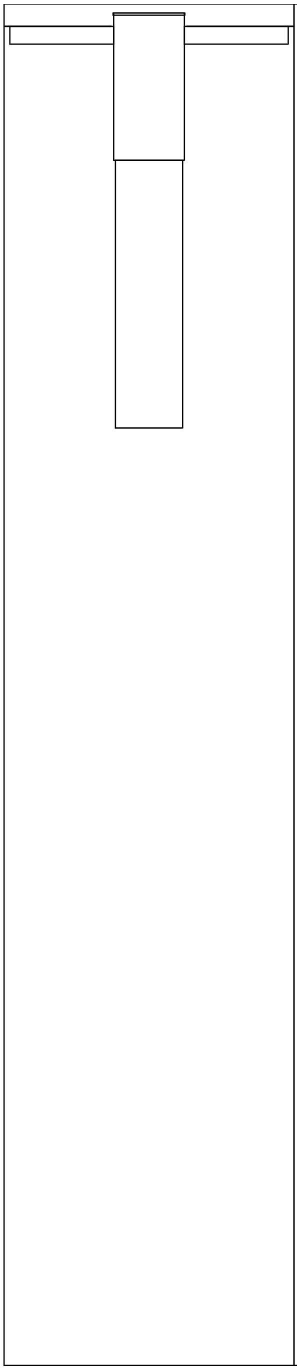
DRILLING CO.:	***Unknown***
DRILLER:	***Unknown***
RIG TYPE:	***Unknown***
DRILLING METHOD:	***Unknown***
DEVELOPMENT DATE:	***Unknown***
LOCATION:	***17 East Hook Cross Road, adjacent to driveway in concrete bunker***

SURFACE ELEVATION: 515 ft amsl

NORTHING: To Be Determined EASTING: To Be Determined

DEPTH FEET	CUM. BLOWN YIELD	VOC (ppm)	LITHOLOGY	GRAPHIC	DEPTH FEET	WELL CONSTRUCTION DETAILS
0	NA				0	6" locking well cap Concrete vault 0 to 4', 6" steel riser casing +1.0 to 4'
25					25	6" dia. steel casing 4' to unknown depth
			GNEISS	▨		
50	NA			▨	50	
				▨		6" dia. borehole, unknown depth to 90'
75				▨	75	
100	NA				100	
125					125	
150	NA				150	
175					175	
200					200	
225					225	
250					250	
275					275	
300					300	

WELL CONSTRUCTION



GEOLOGIC LOG: GRF006

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PROJECT INFORMATION

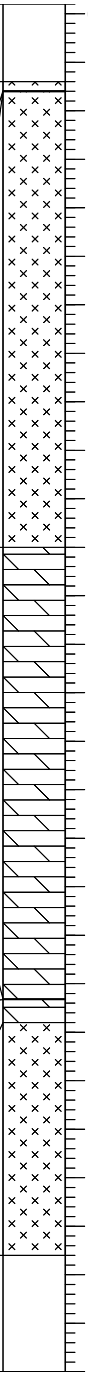
PROJECT: ***Shenandoah Road Residential Wells***
SITE LOCATION: ***Town of East Fishkill, Dutchess Co., NY***
JOB NO.: ***01003.11.0114***
LOGGED BY: ***Lithology based on interpretation of USGS Geophysical Log***
DATES DRILLED: ***Unknown***

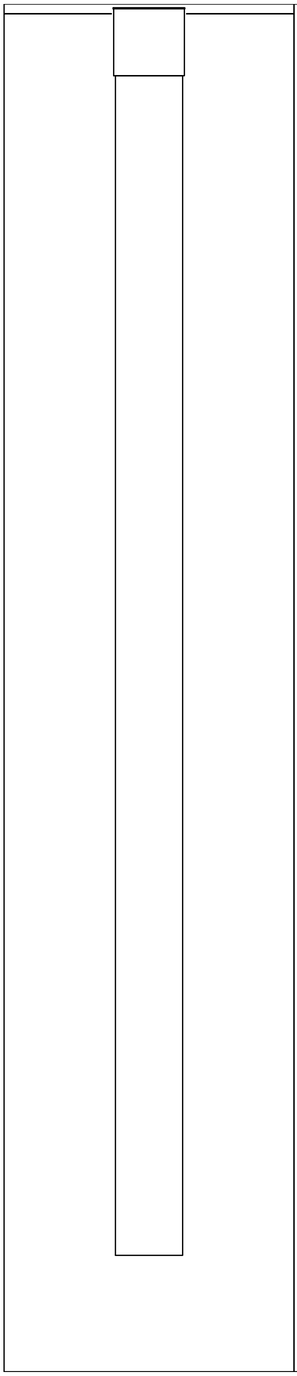
DRILLING INFORMATION

DRILLING CO.: ***Unknown***
DRILLER: ***Unknown***
RIG TYPE: ***Unknown***
DRILLING METHOD: ***Unknown***
DEVELOPMENT DATE: ***Unknown***
LOCATION: ***6 Griffin Lane, front of house on right side***

NOTES:TOC Elevation:341.34 ft amsl

SURFACE ELEVATION: 341 ft amsl
NORTHING: To Be Determined EASTING: To Be Determined





DEPTH FEET	CUM. BLOWN YIELD	VOC (ppm)	LITHOLOGY	DEPTH FEET	WELL CONSTRUCTION DETAILS
0	NA			0	6" locking well cap 6" dia. steel casing +1.3' to 35'
25				25	
50			QUARTZITE	50	
75			WATERBEARING ZONE: 40 ft	75	
100			QUARTZITE	100	
125				125	
150				150	
175				175	
200	NA			200	
225				225	
250				250	
275			DOLOSTONE	275	
300				300	6" dia. borehole, 35' to 640'
325				325	
350				350	
375				375	
400	NA			400	
425				425	
450				450	
475				475	
500			WATERBEARING ZONE: 508 ft	500	
525			DOLOSTONE	525	
550			QUARTZITE	550	
575				575	
600	NA			600	
625				625	
650				650	
675				675	
700				700	

GROUNDWATER SCIENCES CORPORATION

GEOLOGIC LOG: GRF007

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PROJECT INFORMATION

PROJECT: ***Shenandoah Road Residential Wells***
SITE LOCATION: ***Town of East Fishkill, Dutchess Co., NY***
JOB NO.: ***01003.11.0114***
LOGGED BY: ***Lithology based on interpretation of USGS Geophysical Log***
DATES DRILLED: ***Unknown***

DRILLING INFORMATION

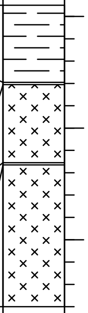
DRILLING CO.: ***Unknown***
DRILLER: ***Unknown***
RIG TYPE: ***Unknown***
DRILLING METHOD: ***Unknown***
DEVELOPMENT DATE: ***Unknown***
LOCATION: ***7 Griffin Lane, to the right of the house***

NOTES: TOC Elevation: 351.00 ft amsl
Well converted from a standpipe to manhole on 4/19/2012

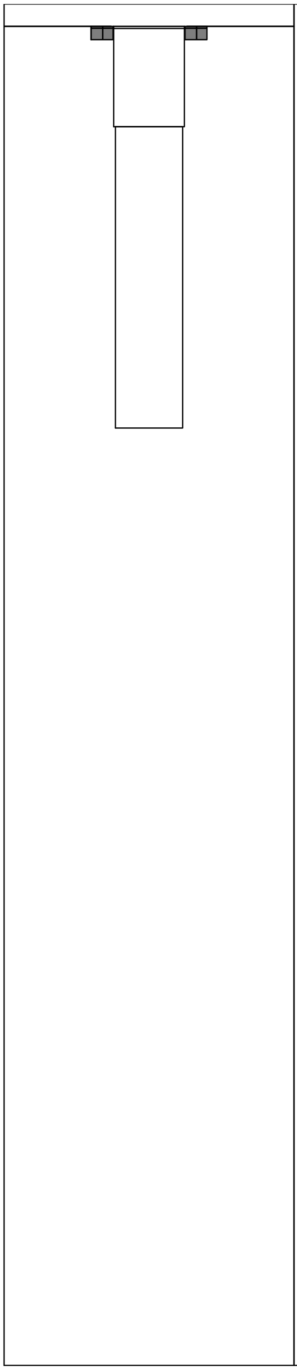
SURFACE ELEVATION: 351.00 ft amsl
NORTHING: To Be Determined EASTING: To Be Determined

DEPTH FEET	CUM. BLOWN YIELD	VOC (ppm)	LITHOLOGY	WELL CONSTRUCTION DETAILS
0	NA			Flushmounted manhole w/ 6" sealing/locking well cap
25	NA		SHALE: Shale/interbedded shale and dolostone/shaly dolostone	6" dia. steel casing 0' to 22.5'
			WATERBEARING ZONE: 40 ft	
50	NA		QUARTZITE	6" dia. borehole, 22.5' to 90'
			WATERBEARING ZONE: 58 ft	
75			QUARTZITE	
	NA			
100				
125				
150				
175				
200				
225				
250				
275				
300				

GRAPHIC



WELL CONSTRUCTION



GROUNDWATER SCIENCES CORPORATION

GEOLOGIC LOG: GRF007 Deep

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PROJECT INFORMATION

PROJECT: ***Shenandoah Road Residential Wells***
SITE LOCATION: ***Town of East Fishkill, Dutchess Co., NY***
JOB NO.: ***01003.11.0114***
LOGGED BY: ***Lithology based on interpretation of USGS Geophysical Log***
DATES DRILLED: ***Unknown***

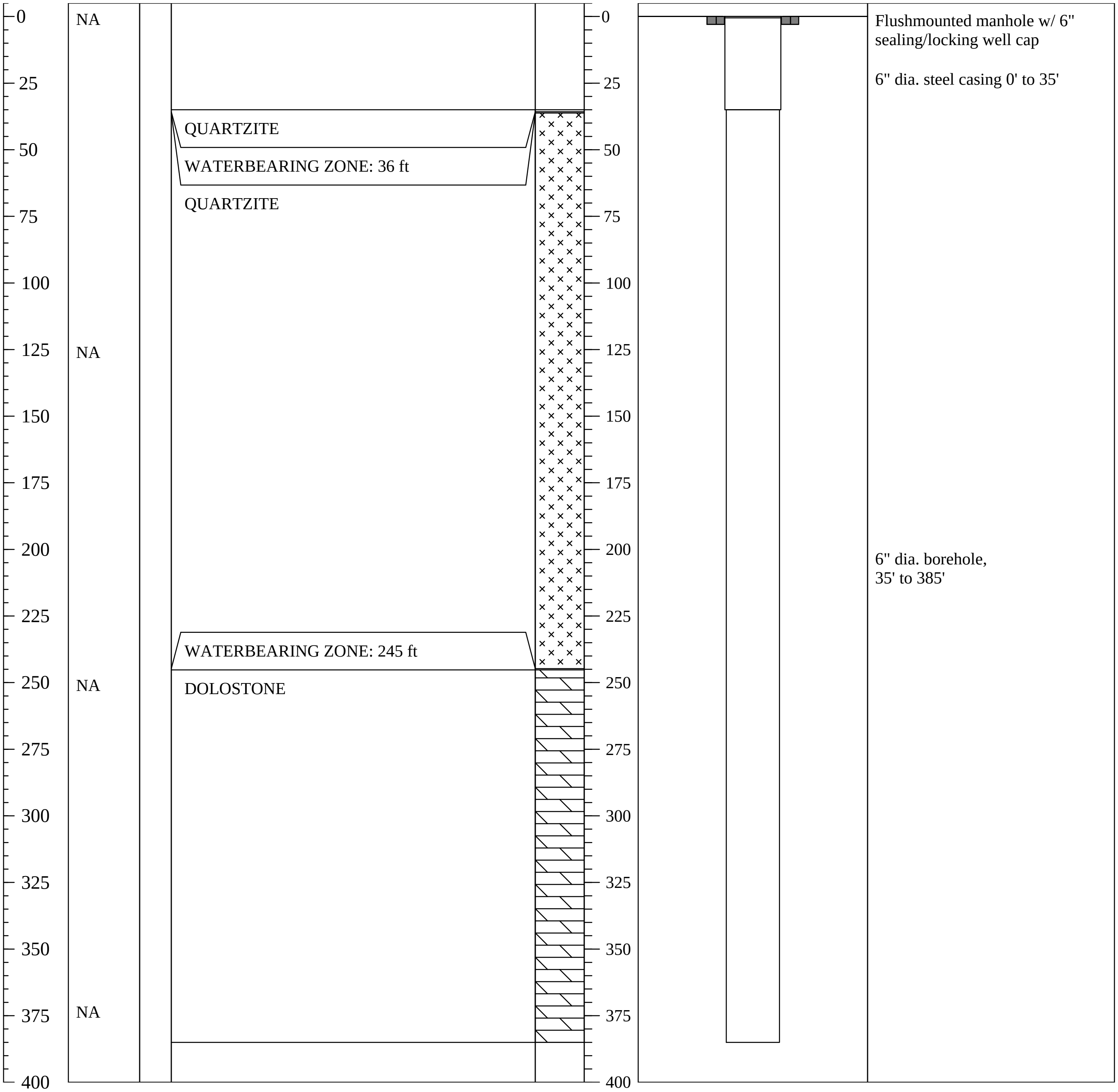
DRILLING INFORMATION

DRILLING CO.: ***Unknown***
DRILLER: ***Unknown***
RIG TYPE: ***Unknown***
DRILLING METHOD: ***Unknown***
DEVELOPMENT DATE: ***Unknown***
LOCATION: ***7 Griffin Lane, to the right of the house***

NOTES: TOC Elevation: 351.00 ft amsl
Well converted from a standpipe to manhole on 4/19/2012

SURFACE ELEVATION: 351.00 ft amsl
NORTHING: To Be Determined EASTING: To Be Determined

DEPTH FEET	CUM. BLOWN YIELD	VOC (ppm)	LITHOLOGY	GRAPHIC	DEPTH FEET	WELL CONSTRUCTION	WELL CONSTRUCTION DETAILS



Depth	Cum. Blown Yield	Lithology
0	NA	
36		QUARTZITE
36		WATERBEARING ZONE: 36 ft
		QUARTZITE
125	NA	
245		WATERBEARING ZONE: 245 ft
250	NA	DOLOSTONE
375	NA	

Flushmounted manhole w/ 6" sealing/locking well cap

6" dia. steel casing 0' to 35'

6" dia. borehole,
35' to 385'

GEOLOGIC LOG: JCK117

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PROJECT INFORMATION

PROJECT: ***Shenandoah Road Residential Wells***
SITE LOCATION: ***Town of East Fishkill, Dutchess Co., NY***
JOB NO.: ***01003.11.0114***
LOGGED BY: ***Lithology based on interpretation of USGS Geophysical Log***
DATES DRILLED: ***Unknown***

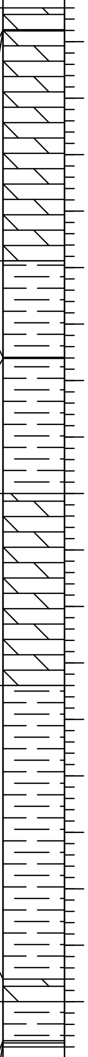
DRILLING INFORMATION

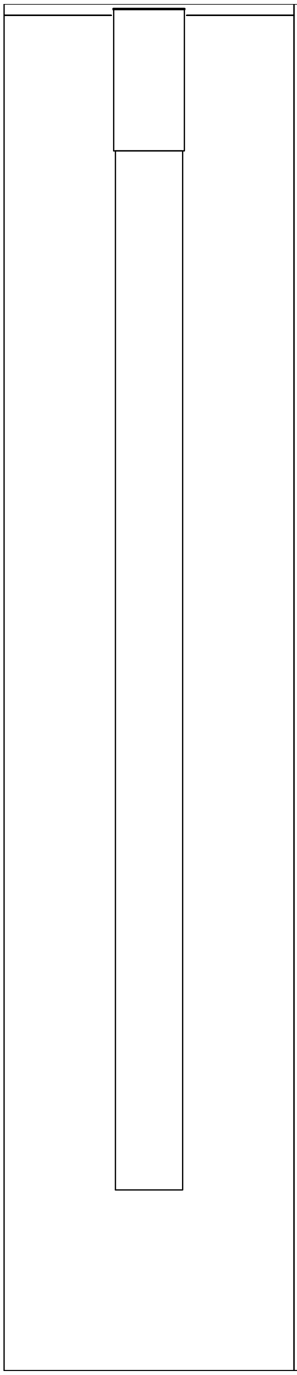
DRILLING CO.: ***Unknown***
DRILLER: ***Unknown***
RIG TYPE: ***Unknown***
DRILLING METHOD: ***Unknown***
DEVELOPMENT DATE: ***Unknown***
LOCATION: ***117 Jackson Road, front yard left side of driveway***

NOTES: TOC Elevation: 322.00 ft amsl

SURFACE ELEVATION: 320 ft amsl
NORTHING: To Be Determined EASTING: To Be Determined

DEPTH FEET	CUM. BLOWN YIELD	VOC (ppm)	LITHOLOGY
0	NA		
60–68			DOLOSTONE
70			WATERBEARING ZONE: 70 ft
70–175			DOLOSTONE
100	NA		
175–215			SHALE: Shale/interbedded shale and dolostone/shaly dolostone
200	NA		
215			WATERBEARING ZONE: 215 ft
215–278			SHALE: Shale/interbedded shale and dolostone/shaly dolostone
278–363			DOLOSTONE
300	NA		
363–485			SHALE: Shale/interbedded shale and dolostone/shaly dolostone
400	NA		
485–498			DOLOSTONE
500	NA		
498–520			SHALE: Shale/interbedded shale and dolostone/shaly dolostone
518			WATERBEARING ZONE: 518 ft
520	NA		





WELL CONSTRUCTION DETAILS

6" locking well cap

6" dia. steel casing +2' to 60'

6" dia. borehole,
60' to 520'

GROUNDWATER SCIENCES CORPORATION

GEOLOGIC LOG: OTN007

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PROJECT INFORMATION

PROJECT: ***Shenandoah Road Residential Wells***
SITE LOCATION: ***Town of East Fishkill, Dutchess Co., NY***
JOB NO.: ***01003.11.0114***
LOGGED BY: ***Lithology based on interpretation of USGS Geophysical Log***
DATES DRILLED: ***Unknown***

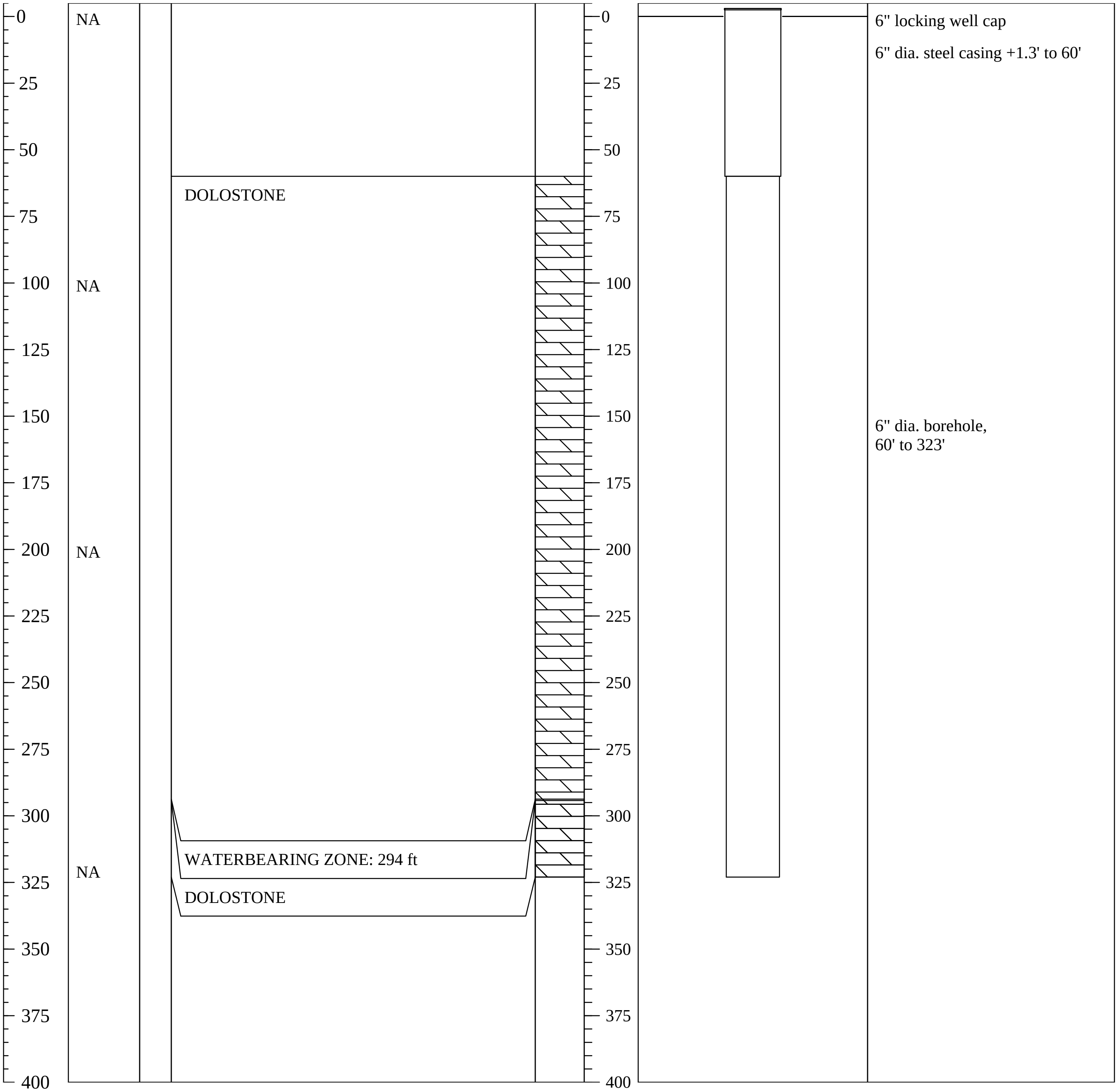
DRILLING INFORMATION

DRILLING CO.: ***Unknown***
DRILLER: ***Unknown***
RIG TYPE: ***Unknown***
DRILLING METHOD: ***Unknown***
DEVELOPMENT DATE: ***Unknown***
LOCATION: ***7 Old Townsend Road***

NOTES: TOC Elevation: 339.17 ft amsl

SURFACE ELEVATION: 337.9 ft amsl
NORTHING: To Be Determined EASTING: To Be Determined

DEPTH FEET	CUM. BLOWN YIELD	VOC (ppm)	LITHOLOGY	GRAPHIC	DEPTH FEET	WELL CONSTRUCTION	WELL CONSTRUCTION DETAILS



NA
NA
NA
NA

DOLOSTONE
WATERBEARING ZONE: 294 ft
DOLOSTONE

6" locking well cap
6" dia. steel casing +1.3' to 60'
6" dia. borehole,
60' to 323'

GROUNDWATER SCIENCES CORPORATION

GEOLOGIC LOG: SEY004

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PROJECT INFORMATION

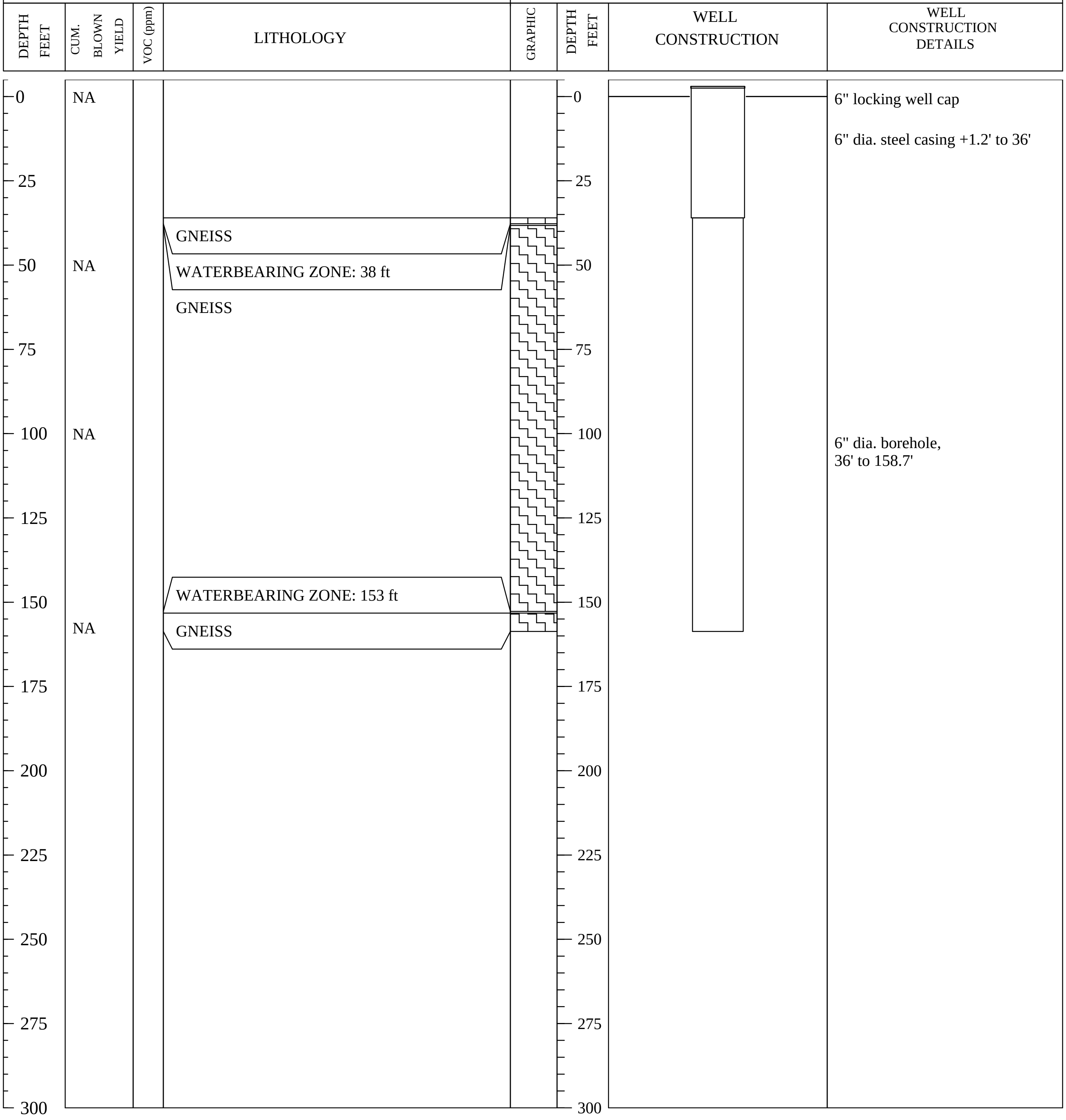
PROJECT: ***Shenandoah Road Residential Wells***
SITE LOCATION: ***Town of East Fishkill, Dutchess Co., NY***
JOB NO.: ***01003.11.0114***
LOGGED BY: ***Lithology based on interpretation of USGS Geophysical Log***
DATES DRILLED: ***Unknown***

DRILLING INFORMATION

DRILLING CO.: ***Unknown***
DRILLER: ***Unknown***
RIG TYPE: ***Unknown***
DRILLING METHOD: ***Unknown***
DEVELOPMENT DATE: ***Unknown***
LOCATION: ***4 Seymour Lane, front yard right of driveway in wooden barrel***

NOTES: TOC Elevation: 361.20 ft amsl

SURFACE ELEVATION: 360 ft amsl
NORTHING: To Be Determined EASTING: To Be Determined



GROUNDWATER SCIENCES CORPORATION

GEOLOGIC LOG: SEY005D/S

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PROJECT INFORMATION

PROJECT: ***Shenandoah Road Residential Well Construction***

SITE LOCATION: ***Town of East Fishkill, Dutchess Co., NY***

JOB NO.: ***01003.11.0105***

LOGGED BY: ***Lithology based on interpretation of USGS Geophysical Log***

DATES DRILLED: ***Unknown***

DRILLING INFORMATION

DRILLING CO.: ***Unknown***

DRILLER: ***Unknown***

RIG TYPE: ***Unknown***

DRILLING METHOD: ***Unknown***

DEVELOPMENT DATE: ***Unknown***

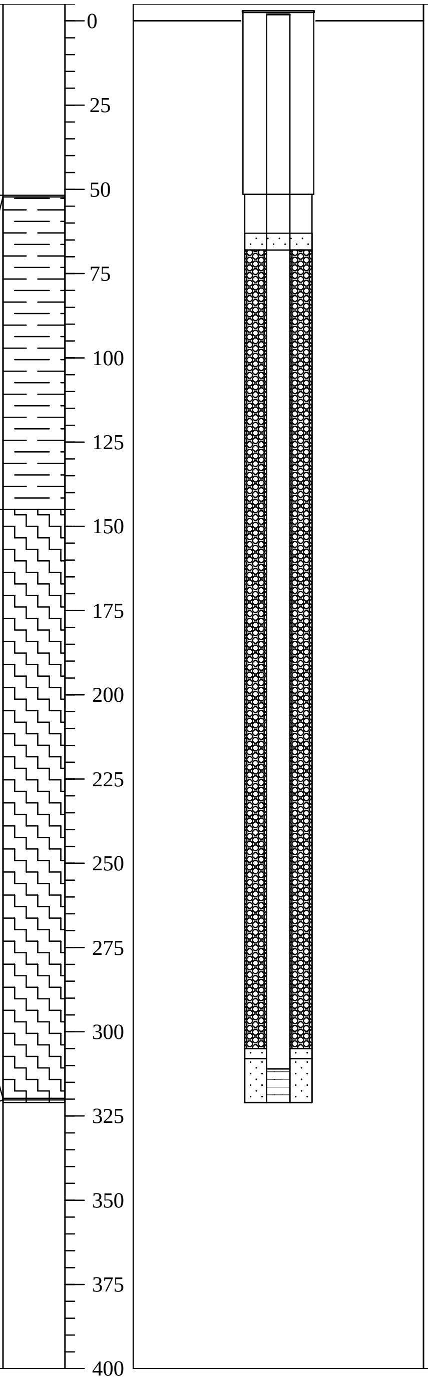
LOCATION: ***5 Seymour Lane, right side of house behind rock***

NOTES: SWL (3/30/2011): SEY005D Art./SEY005S 7.00 ft. below TOC
TOC Elevation: 346.20 / 346.20 ft amsl
Well construction completed on 3/24/2011 by MWR

SURFACE ELEVATION: 345 ft amsl

NORTHING: To Be Determined EASTING: To Be Determined

DEPTH FEET	CUM. BLOWN YIELD	VOC (ppm)	LITHOLOGY
0	NA		
53			WATERBEARING ZONE: 53 ft
53–145			SHALE: Shale/interbedded shale and dolostone/shaly dolostone
100	NA		
145–320			GNEISS
200	NA		
300	NA		
320			WATERBEARING ZONE: 320 ft
325	NA		



WELL CONSTRUCTION DETAILS

6" locking well cap

6" dia. steel casing +1.2 to 51.5'

Open annulus is SEY005S

Open 2x6 annulus, 0 to 63'

#3 and #4 grade choke sand, 63' to 68'

2" dia. PVC casing +1.2' to 250'

Bentonite chip 6"x2" annular seal, 68' to 305'

6" dia. borehole, 51.5' to 321'

#3 and #4 grade choke sand, 305' to 308'

2 grade sand pack, 308' to 321'

2" dia. 30 Slot PVC screen 311' to 321'

Screened interval is SEY005D

GROUNDWATER SCIENCES CORPORATION

GEOLOGIC LOG: SEY006

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PROJECT INFORMATION

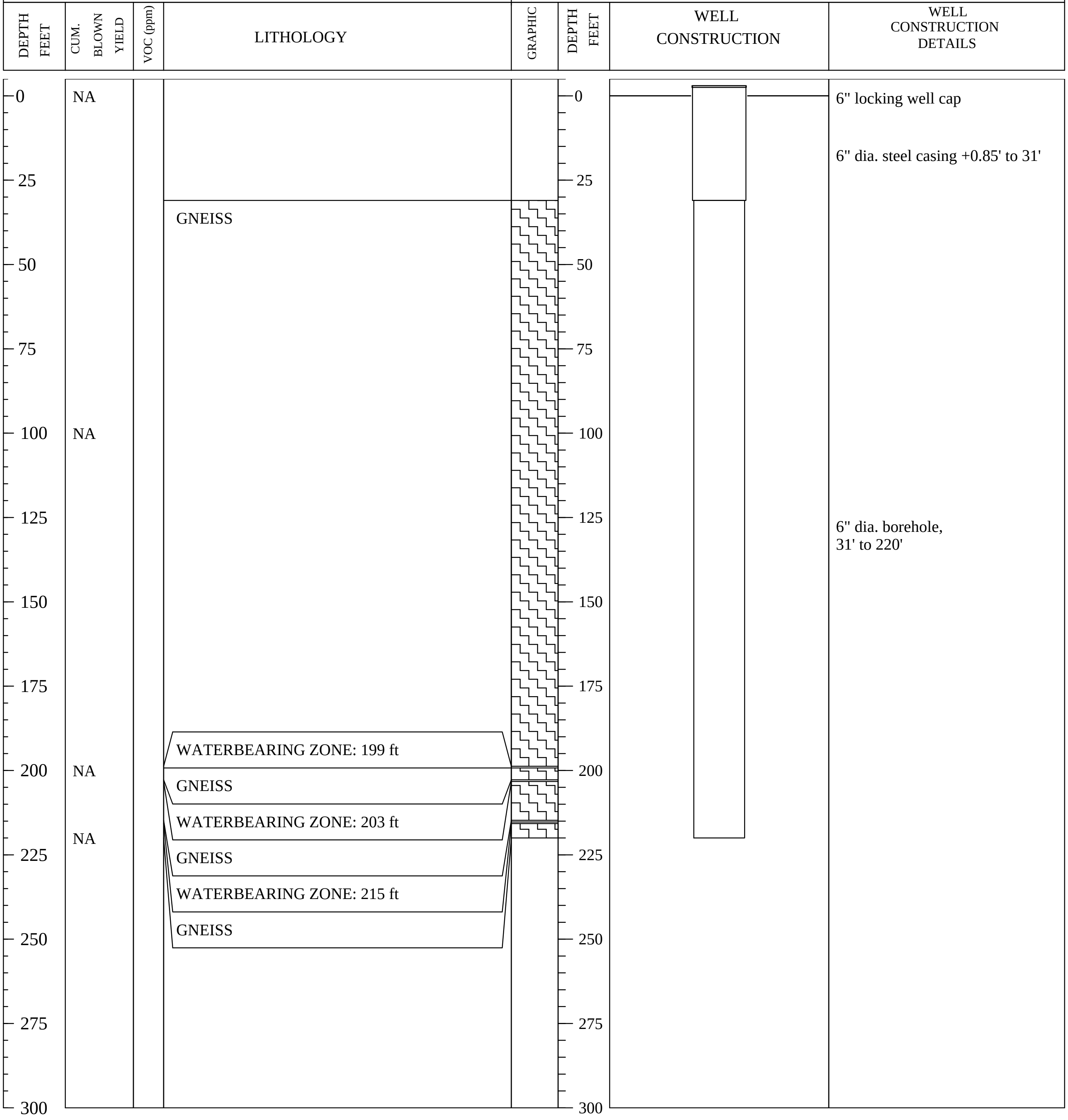
PROJECT: ***Shenandoah Road Residential Wells***
SITE LOCATION: ***Town of East Fishkill, Dutchess Co., NY***
JOB NO.: ***01003.11.0114***
LOGGED BY: ***Lithology based on interpretation of USGS Geophysical Log***
DATES DRILLED: ***Unknown***

DRILLING INFORMATION

DRILLING CO.: ***Unknown***
DRILLER: ***Unknown***
RIG TYPE: ***Unknown***
DRILLING METHOD: ***Unknown***
DEVELOPMENT DATE: ***Unknown***
LOCATION: ***6 Seymour Lane,back yard behind shed near Shenandoah Road***

NOTES:TOC Elevation: 365.85 ft amsl

SURFACE ELEVATION: 365 ft amsl
NORTHING: To Be Determined EASTING: To Be Determined



Depth (ft)	Cum. Blown Yield
0	NA
100	NA
200	NA
~220	NA

LITHOLOGY:

GNEISS
WATERBEARING ZONE: 199 ft
GNEISS
WATERBEARING ZONE: 203 ft
GNEISS
WATERBEARING ZONE: 215 ft
GNEISS

WELL CONSTRUCTION DETAILS:

6" locking well cap
6" dia. steel casing +0.85' to 31'
6" dia. borehole,
31' to 220'

GROUNDWATER SCIENCES CORPORATION

GEOLOGIC LOG: SEY007D/S

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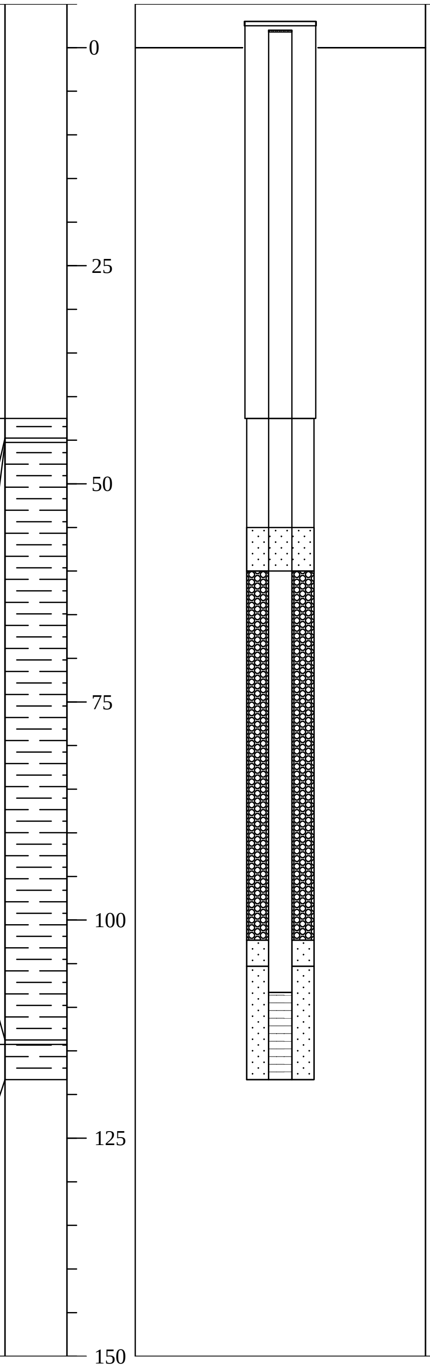
PROJECT INFORMATION		DRILLING INFORMATION	
PROJECT:	*Shenandoah Road Residential Well Construction*	DRILLING CO.:	*Unknown*
SITE LOCATION:	*Town of East Fishkill, Dutchess Co., NY*	DRILLER:	*Unknown*
JOB NO.:	*01003.11.0105*	RIG TYPE:	*Unknown*
LOGGED BY:	*USGS*	DRILLING METHOD:	*Unknown*
DATES DRILLED:	*Unknown*	DEVELOPMENT DATE:	*Unknown*
		LOCATION:	*7 Seymour Lane, in front yard behind rock*

NOTES: SWL (3/10/2011): SEY007D 0.30/SEY007S 5.60 ft. below TOC
TOC Elevation: 346.66 / 346.90 ft amsl
Well construction completed on 10/29/2010 by MWR

SURFACE ELEVATION: 345 ft amsl

NORTHING: To Be Determined EASTING: To Be Determined

DEPTH FEET	CUM. BLOWN YIELD	VOC (ppm)	LITHOLOGY
0	NA		
25			
			SHALE: Shale/interbedded shale and dolostone/shaly dolostone (dolostone unit)
50	NA		WATERBEARING ZONE: 45 ft
			SHALE: Shale/interbedded shale and dolostone/shaly dolostone (dolostone unit)
75			
100	NA		
			WATERBEARING ZONE: 114 ft
	NA		SHALE: Shale/interbedded shale and dolostone/shaly dolostone (dolostone unit)
125			
150			



WELL CONSTRUCTION DETAILS

6" locking well cap

6" dia. steel casing +1.5 to 42.5'

6" dia. borehole, 15' to 118.3'

Open annulus is SEY007S

Open 2x6 annulus, 0 to 55'

#3 and #4 grade choke sand, 55' to 60'

2" dia. PVC casing +1.3' to 108.3'

Bentonite chip 6"x2" annular seal, 60' to 102.3'

#3 and #4 grade choke sand, 102.3' to 105.3'

2 grade sand pack, 105.3' to 118.3'

2" dia. 30 Slot PVC screen 108.3' to 118.3'

Screened interval is SEY007D

GROUNDWATER SCIENCES CORPORATION

GEOLOGIC LOG: SHN466

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PROJECT INFORMATION

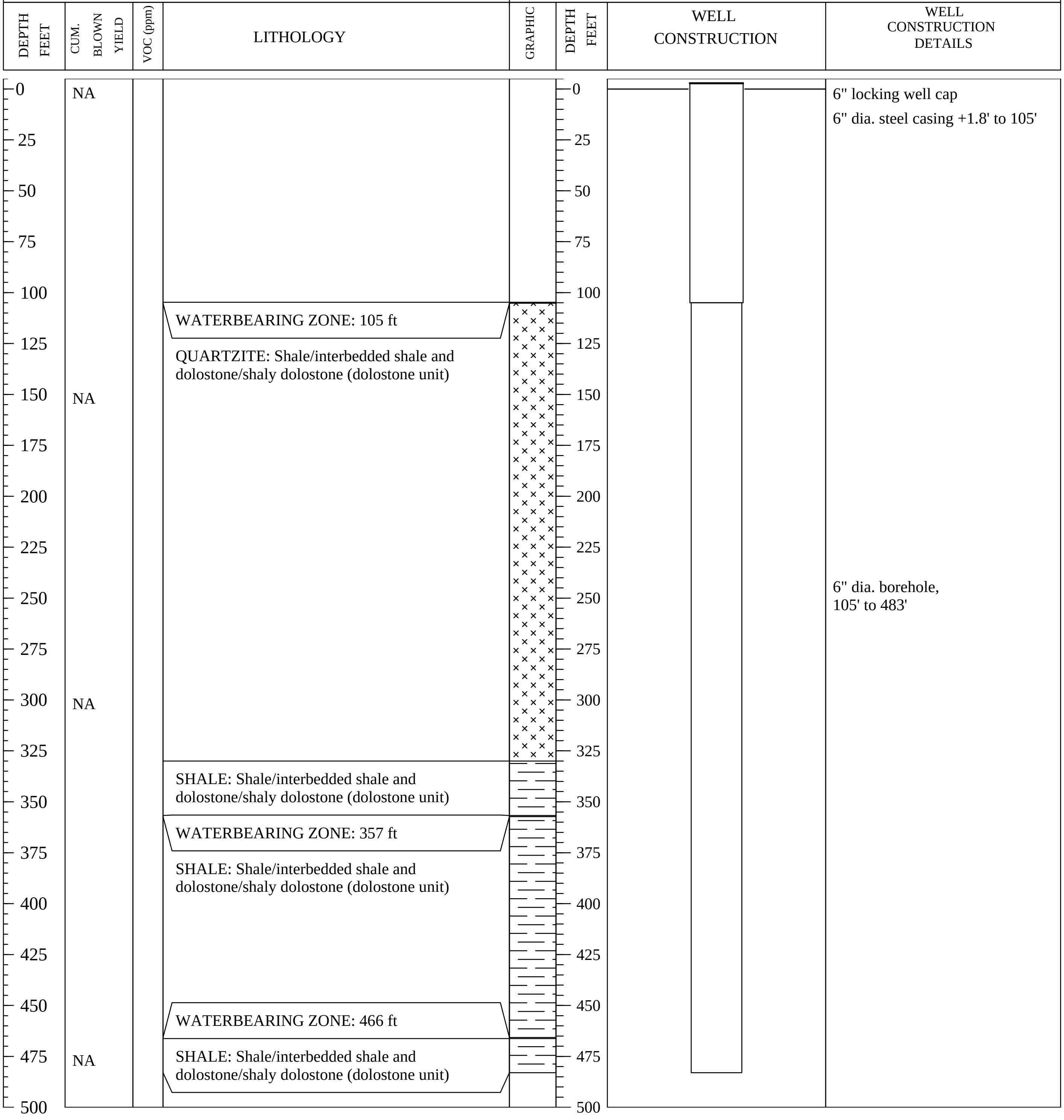
PROJECT: ***Shenandoah Road Residential Wells***
SITE LOCATION: ***Town of East Fishkill, Dutchess Co., NY***
JOB NO.: ***01003.11.0114***
LOGGED BY: ***Lithology based on interpretation of USGS Geophysical Log***
DATES DRILLED: ***Unknown***

NOTES: TOC Elevation: 334.35 ft amsl

DRILLING INFORMATION

DRILLING CO.: ***Unknown***
DRILLER: ***Unknown***
RIG TYPE: ***Unknown***
DRILLING METHOD: ***Unknown***
DEVELOPMENT DATE: ***Unknown***
LOCATION: ***466 Shenandoah Road, front yard***

SURFACE ELEVATION: 333.55 ft amsl
NORTHING: To Be Determined EASTING: To Be Determined



WATERBEARING ZONE: 105 ft

QUARTZITE: Shale/interbedded shale and dolostone/shaly dolostone (dolostone unit)

SHALE: Shale/interbedded shale and dolostone/shaly dolostone (dolostone unit)

WATERBEARING ZONE: 357 ft

SHALE: Shale/interbedded shale and dolostone/shaly dolostone (dolostone unit)

WATERBEARING ZONE: 466 ft

SHALE: Shale/interbedded shale and dolostone/shaly dolostone (dolostone unit)

6" locking well cap
6" dia. steel casing +1.8' to 105'

6" dia. borehole,
105' to 483'

GROUNDWATER SCIENCES CORPORATION

GEOLOGIC LOG: SHN472

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PROJECT INFORMATION

PROJECT: ***Shenandoah Road Residential Wells***
SITE LOCATION: ***Town of East Fishkill, Dutchess Co., NY***
JOB NO.: ***01003.11.0114***
LOGGED BY: ***Lithology based on interpretation of USGS Geophysical Log***
DATES DRILLED: ***Unknown***

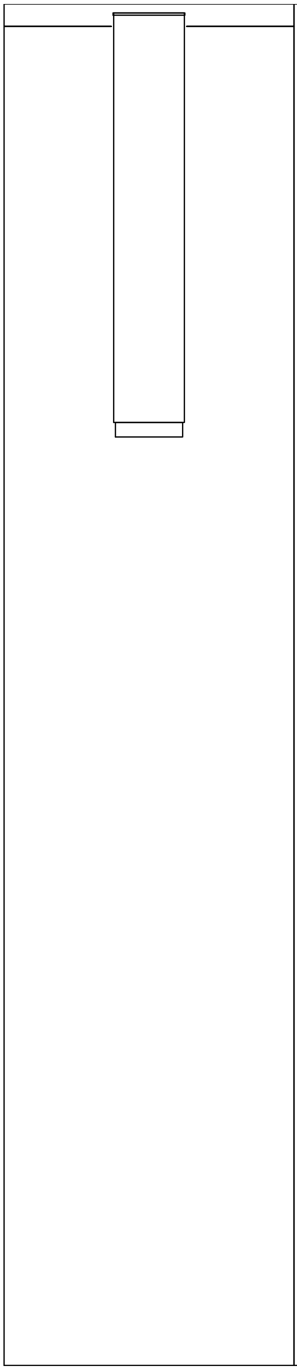
DRILLING INFORMATION

DRILLING CO.: ***Unknown***
DRILLER: ***Unknown***
RIG TYPE: ***Unknown***
DRILLING METHOD: ***Unknown***
DEVELOPMENT DATE: ***Unknown***
LOCATION: ***472 Shenandoah Road***

NOTES: TOC Elevation: 351.33 ft amsl

SURFACE ELEVATION: 349.73 ft amsl
NORTHING: To Be Determined EASTING: To Be Determined

DEPTH FEET	CUM. BLOWN YIELD	VOC (ppm)	LITHOLOGY	GRAPHIC	DEPTH FEET	WELL CONSTRUCTION	WELL CONSTRUCTION DETAILS
0	NA				0		6" locking well cap 6" dia. steel casing +1.8' to 88.75'
25			QUARTZITE: Lithology inferred, well not logged below the bottom of the casing	× × ×	25		
50					50		6" dia. borehole, 88.75' to 92'
75					75		
100	NA				100		
125					125		
150					150		
175					175		
200					200		
225					225		
250					250		
275					275		
300					300		



GROUNDWATER SCIENCES CORPORATION

GEOLOGIC LOG: SHN478D/S

PROJECT INFORMATION

PROJECT:	*Shenandoah Road Residential Well Construction*
SITE LOCATION:	*Town of East Fishkill, Dutchess Co., NY*
JOB NO.:	*01003.11.0105*
LOGGED BY:	*Lithology based on interpretation of USGS Geophysical Log*
DATES DRILLED:	*Unknown*

DRILLING INFORMATION

DRILLING CO.:	*Unknown*
DRILLER:	*Unknown*
RIG TYPE:	*Unknown*
DRILLING METHOD:	*Unknown*
DEVELOPMENT DATE:	*Unknown*
LOCATION:	*478 Shenandoah Road, inf front of house*

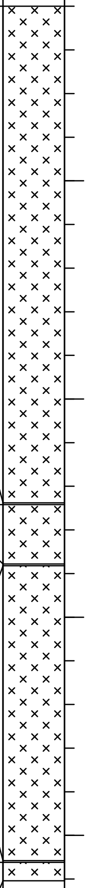
NOTES: SWL (3/10/2011): SHN478D 30.00/SHN478S 28.00 ft. below TOC
TOC Elevation: 356.98 / 357.36 ft amsl
Well construction completed 2/15/2011 by MWR

SURFACE ELEVATION: 355.06 ft amsl

NORTHING: To Be Determined EASTING: To Be Determined

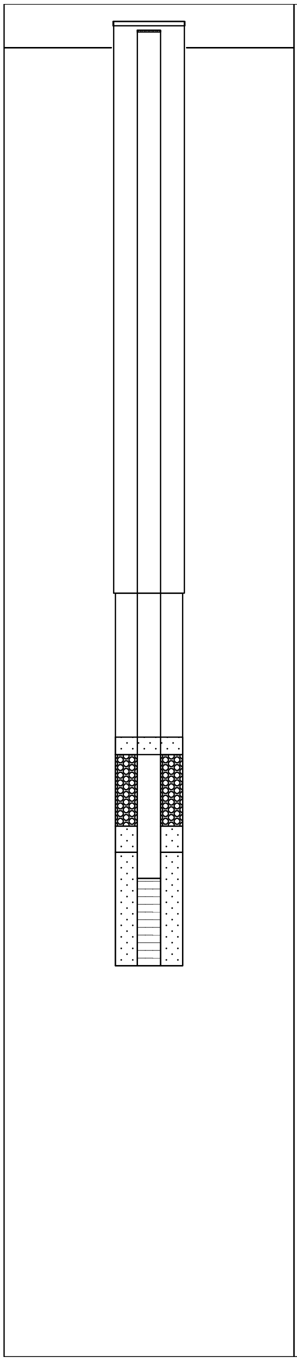
DEPTH FEET	CUM. BLOWN YIELD	VOC (ppm)	LITHOLOGY
0	NA		
			QUARTZITE
25			
50	NA		
			WATERBEARING ZONE: 62 ft
			QUARTZITE
			WATERBEARING ZONE: 69 ft
75			QUARTZITE
100	NA		WATERBEARING ZONE: 103 ft
			QUARTZITE
125			
150			

GRAPHIC



DEPTH FEET

WELL CONSTRUCTION



WELL CONSTRUCTION DETAILS

6" locking well cap

6" dia. steel casing +2.3 to 62.5'

Open annulus is SHN478S

2" dia. PVC casing +1.9' to 95.2'

6" dia. borehole, 62.5' to 105.2'

Open 2x6 annulus, 0 to 79'

#3 and #4 grade choke sand, 79' to 81'

Bentonite chip 6"x2" annular seal, 81' to 89.2'

#3 and #4 grade choke sand, 89.2' to 92.2'

2 grade sand pack, 92.2' to 105.2'

2" dia. 30 Slot PVC screen 95.2' to 105.2'

Screened interval is SHN478D

GROUNDWATER SCIENCES CORPORATION

GEOLOGIC LOG: SHN499D/S

Page 1 of 1

PROJECT INFORMATION

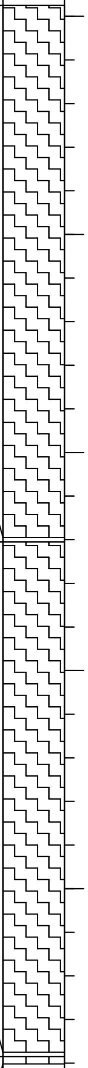
PROJECT: *Shenandoah Road Residential Well Construction*
SITE LOCATION: *Town of East Fishkill, Dutchess Co., NY*
JOB NO.: *01003.11.0105*
LOGGED BY: *USGS*
DATES DRILLED: *Unknown*

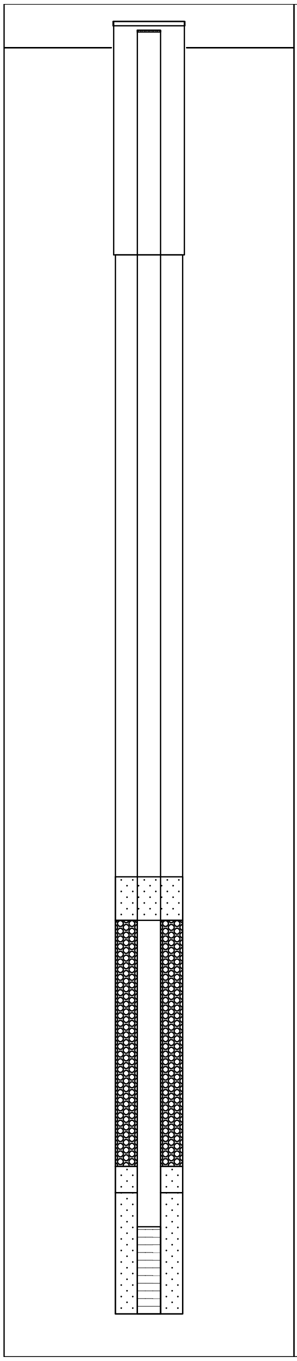
DRILLING INFORMATION

DRILLING CO.: *Unknown*
DRILLER: *Unknown*
RIG TYPE: *Unknown*
DRILLING METHOD: *Unknown*
DEVELOPMENT DATE: *Unknown*
LOCATION: *499 Shenandoah Road, in front of house*

NOTES: SWL (3/11/2011): SHN499D 21.28/SHN499S 20.49 ft. below TOC
TOC Elevation: 406.70 / 406.62 ft amsl
Well construction completed on 10/28/2010 by MWR

SURFACE ELEVATION: 405 ft amsl
NORTHING: To Be Determined EASTING: To Be Determined





DEPTH FEET	CUM. BLOWN YIELD	VOC (ppm)	LITHOLOGY	DEPTH FEET	WELL CONSTRUCTION DETAILS
0	NA			0	6" locking well cap
					6" dia. steel casing +1.7 to 23.75'
25			GNEISS	25	
					Open annulus is SHN499S
50	NA			50	2" dia. PVC casing +1.7' to 135.1'
					Open 2x6 annulus, 0 to 95'
75				75	
			WATERBEARING ZONE: 85 ft		
			GNEISS		6" dia. borehole, 23.8' to 145.1'
					#3 and #4 grade choke sand, 95' to 100'
100				100	
					Bentonite chip 6"x2" annular seal, 100' to 128.2'
125				125	
					#3 and #4 grade choke sand, 128.2' to 131.2'
					# 2 grade sand pack, 131.2' to 145.1'
			WATERBEARING ZONE: 144 ft		2" dia. 30 Slot PVC screen 135.1' to 145.1'
	NA		GNEISS		Screened interval is SHN499D
150				150	

GROUNDWATER SCIENCES CORPORATION

GEOLOGIC LOG: SHN589

PROJECT INFORMATION

PROJECT: *Shenandoah Road Residential Wells*
SITE LOCATION: *Town of East Fishkill, Dutchess Co., NY*
JOB NO.: *01003.11.0114*
LOGGED BY: *Lithology based on interpretation of USGS Geophysical Log*
DATES DRILLED: *Unknown*

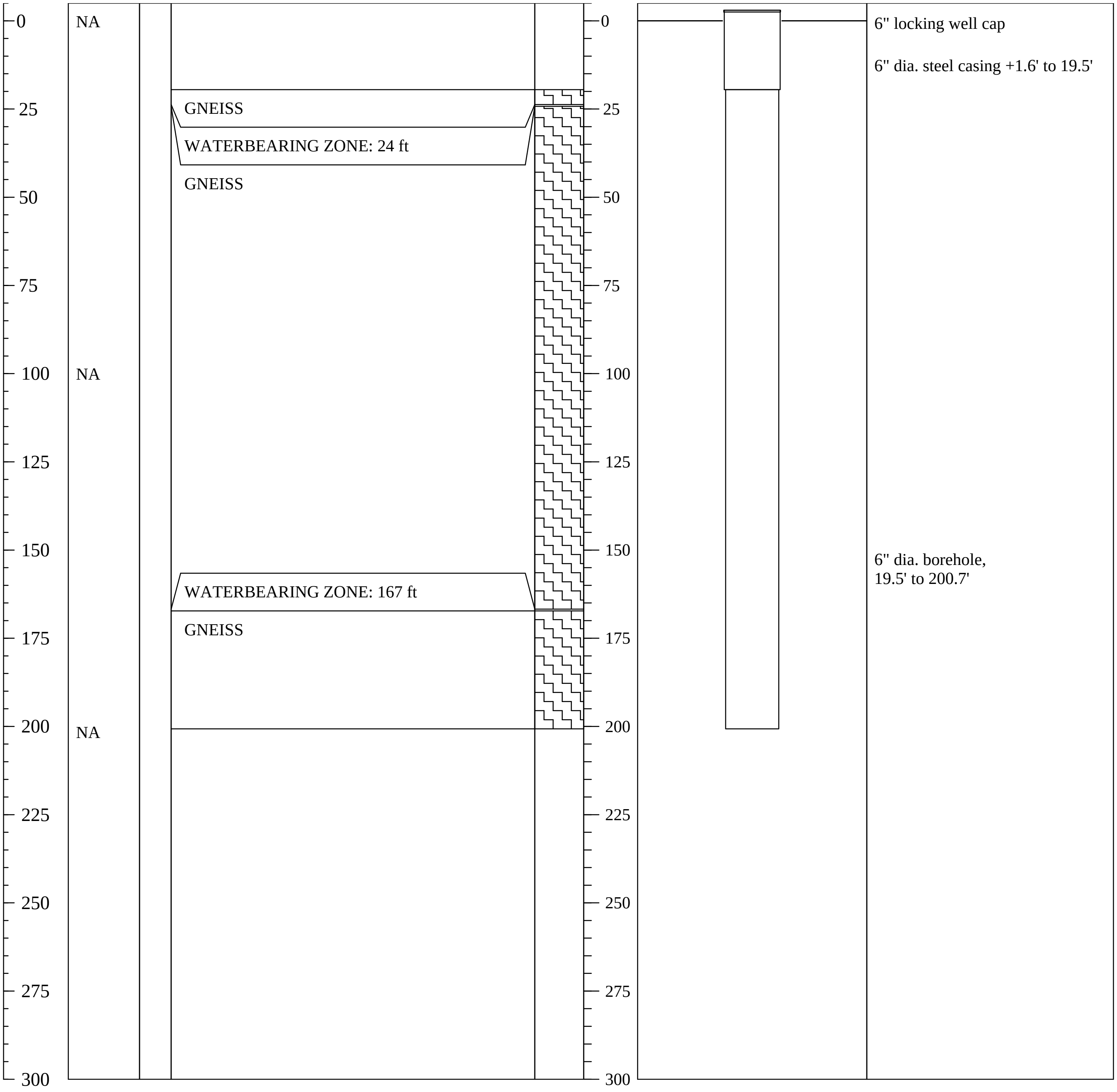
DRILLING INFORMATION

DRILLING CO.: *Unknown*
DRILLER: *Unknown*
RIG TYPE: *Unknown*
DRILLING METHOD: *Unknown*
DEVELOPMENT DATE: *Unknown*
LOCATION: *589 Shenandoah Road, end of driveway*

NOTES: TOC Elevation: 361.60 ft amsl

SURFACE ELEVATION: 360 ft amsl
NORTHING: To Be Determined EASTING: To Be Determined

DEPTH FEET	CUM. BLOWN YIELD	VOC (ppm)	LITHOLOGY	GRAPHIC	DEPTH FEET	WELL CONSTRUCTION	WELL CONSTRUCTION DETAILS



6" locking well cap

6" dia. steel casing +1.6' to 19.5'

6" dia. borehole,
19.5' to 200.7'

GROUNDWATER SCIENCES CORPORATION

GEOLOGIC LOG: SHN591

Page 1 of 1

PROJECT INFORMATION

PROJECT:	***Shenandoah Road Residential Wells***
SITE LOCATION:	***Town of East Fishkill, Dutchess Co., NY***
JOB NO.:	***01003.11.0114***
LOGGED BY:	***Lithology based on interpretation of USGS Geophysical Log***
DATES DRILLED:	***Unknown***

DRILLING INFORMATION

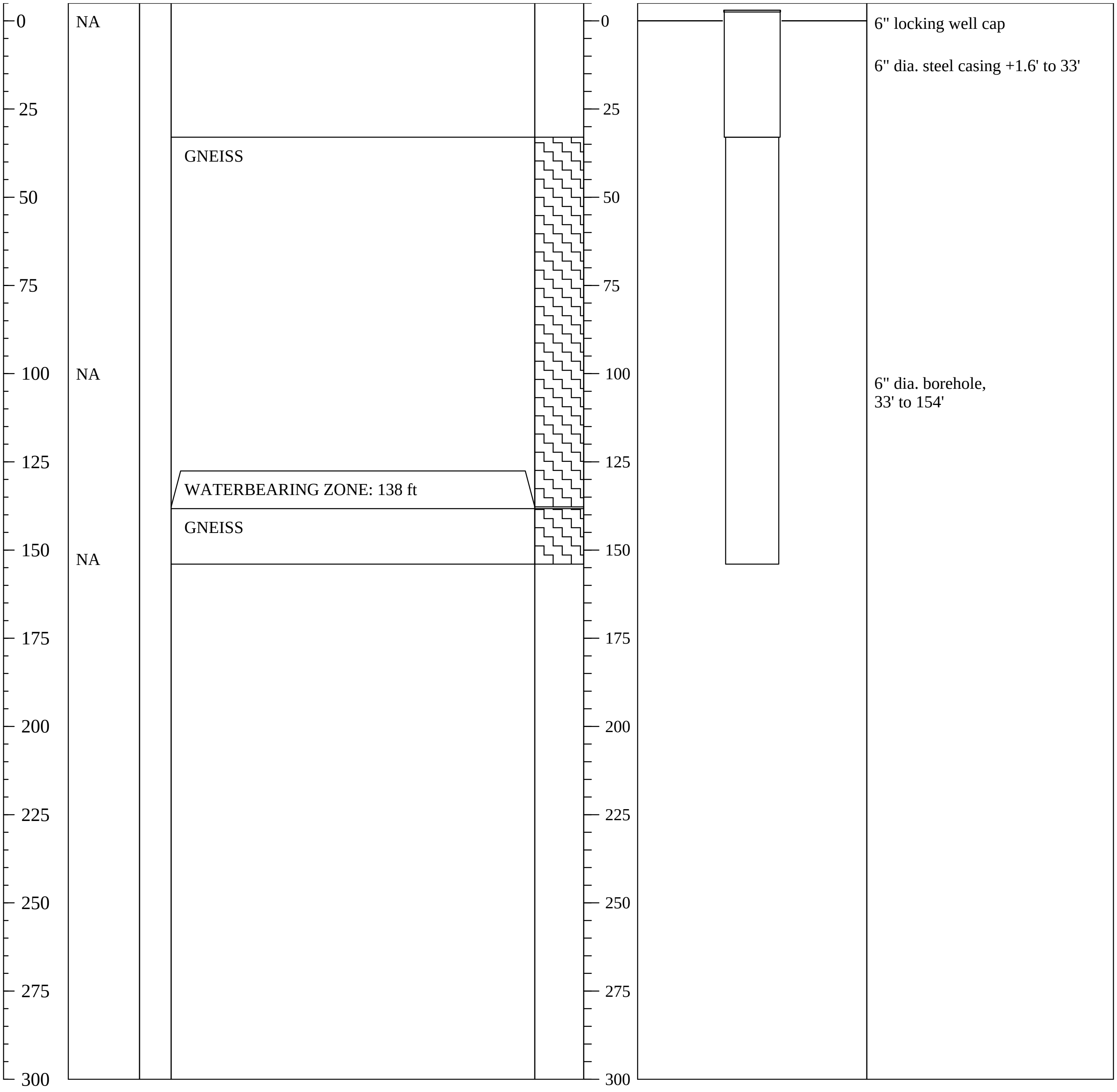
DRILLING CO.:	***Unknown***
DRILLER:	***Unknown***
RIG TYPE:	***Unknown***
DRILLING METHOD:	***Unknown***
DEVELOPMENT DATE:	***Unknown***
LOCATION:	***591 Shenandoah Road***

NOTES: TOC Elevation: 356.10 ft amsl

SURFACE ELEVATION: 355 ft amsl

NORTHING: To Be Determined EASTING: To Be Determined

DEPTH FEET	CUM. BLOWN YIELD	VOC (ppm)	LITHOLOGY	GRAPHIC	DEPTH FEET	WELL CONSTRUCTION	WELL CONSTRUCTION DETAILS



GNEISS

WATERBEARING ZONE: 138 ft

GNEISS

6" locking well cap

6" dia. steel casing +1.6' to 33'

6" dia. borehole,
33' to 154'

GROUNDWATER SCIENCES CORPORATION

GEOLOGIC LOG: SHN603

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PROJECT INFORMATION

PROJECT: ***Shenandoah Road Residential Wells***

SITE LOCATION: ***Town of East Fishkill, Dutchess Co., NY***

JOB NO.: ***01003.11.0114***

LOGGED BY: ***Lithology based on interpretation of USGS Geophysical Log***

DATES DRILLED: ***Unknown***

DRILLING INFORMATION

DRILLING CO.: ***Unknown***

DRILLER: ***Unknown***

RIG TYPE: ***Unknown***

DRILLING METHOD: ***Unknown***

DEVELOPMENT DATE: ***Unknown***

LOCATION: ***603 Shenandoah Road, end of driveway***

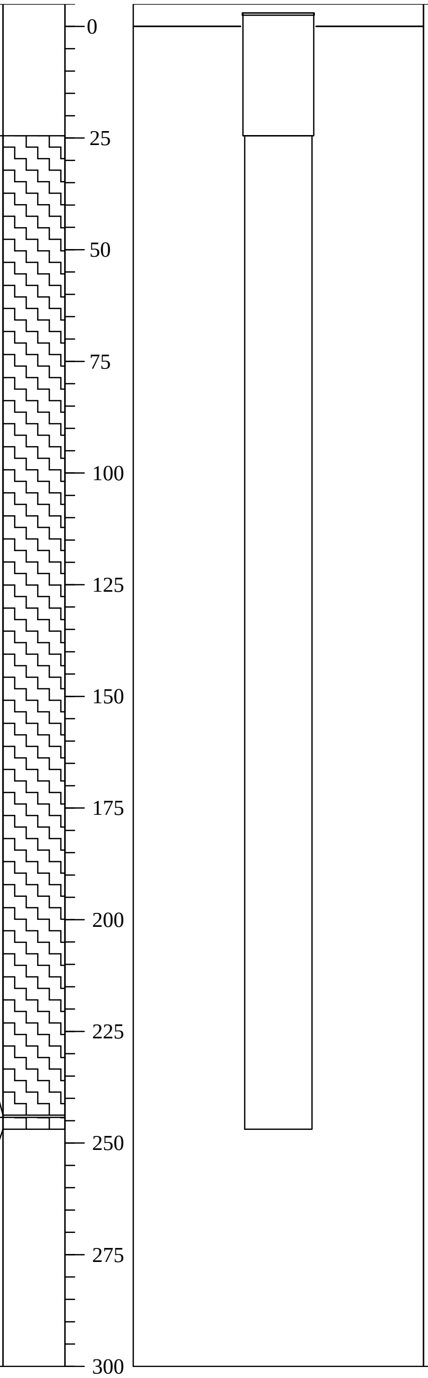
NOTES: TOC Elevation: 349.20 ft amsl

SURFACE ELEVATION: 348 ft amsl

NORTHING: To Be Determined EASTING: To Be Determined

DEPTH FEET	CUM. BLOWN YIELD	VOC (ppm)	LITHOLOGY	WELL CONSTRUCTION DETAILS
0	NA			6" locking well cap 6" dia. steel casing +1.2' to 24.5'
25			GNEISS	
50				
75				
100	NA			
125				
150				6" dia. borehole, 24.5' to 246.9'
175				
200	NA			
225				
			WATERBEARING ZONE: 244 ft	
250	NA		GNEISS	
275				
300				

GRAPHIC | DEPTH FEET | WELL CONSTRUCTION



GROUNDWATER SCIENCES CORPORATION

GEOLOGIC LOG: STN051

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PROJECT INFORMATION

PROJECT: ***Shenandoah Road Residential Wells***
SITE LOCATION: ***Town of East Fishkill, Dutchess Co., NY***
JOB NO.: ***01003.11.0114***
LOGGED BY: ***Lithology based on interpretation of USGS Geophysical Log***
DATES DRILLED: ***Unknown***

DRILLING INFORMATION

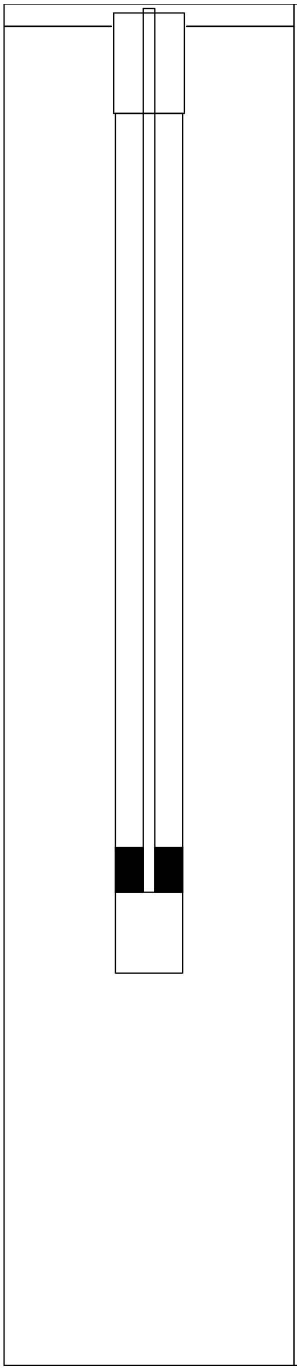
DRILLING CO.: ***Unknown***
DRILLER: ***Unknown***
RIG TYPE: ***Unknown***
DRILLING METHOD: ***Unknown***
DEVELOPMENT DATE: ***Unknown***
LOCATION: ***51 Stone Ridge Lane***

NOTES: SWL (4/17/2011): STN051D 81.31 / STN051S 79.29 ft. below TOC
TOC Elevation: 536.35 ft / 536.85 amsl

SURFACE ELEVATION: 535 ft amsl
NORTHING: To Be Determined EASTING: To Be Determined

DEPTH FEET	CUM. BLOWN YIELD	VOC (ppm)	LITHOLOGY	WELL CONSTRUCTION DETAILS
0	NA			6" dia. steel casing +1.35' to 19.5'
25			GNEISS	
50				6" dia. borehole, 19.5' to 212.1'
75				
100	NA		WATERBEARING ZONE: 107 ft GNEISS	Zone above packer is STN051S
125				
150				
175				
200	NA NA		WATERBEARING ZONE: 205 ft GNEISS	Packer installed on 3/2011 from 184' to 194' below ground surface. One inch PVC pipe extends from the packer to 2 ft above ground surface.
225				Zone below packer is STN051D
250				
275				
300				

WELL CONSTRUCTION



GROUNDWATER SCIENCES CORPORATION

GEOLOGIC LOG: TWN134

Page 1 of 1

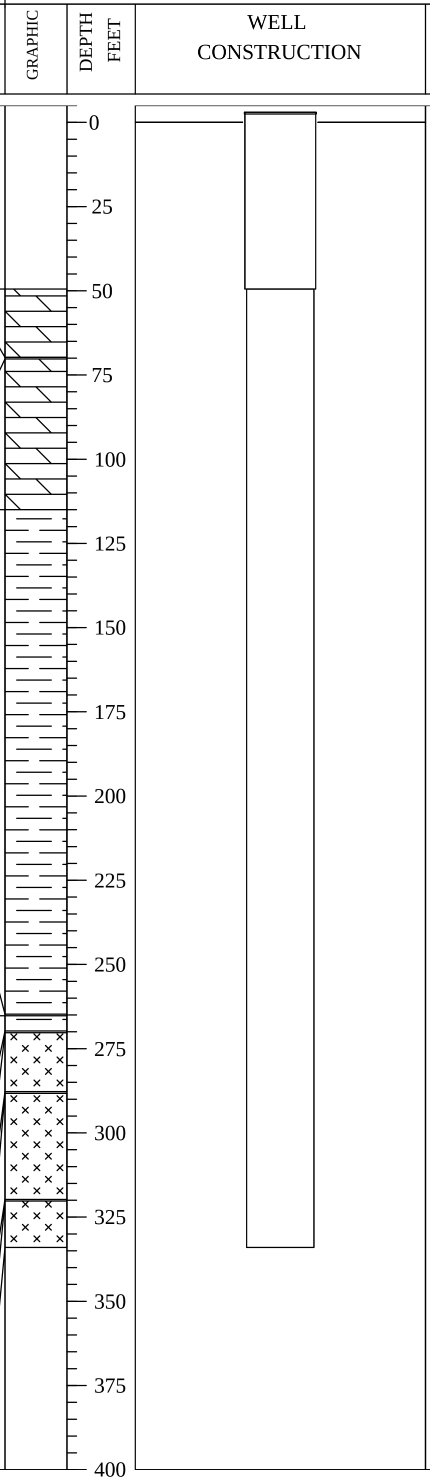
PROJECT INFORMATION		DRILLING INFORMATION	
PROJECT:	***Shenandoah Road Residential Wells***	DRILLING CO.:	***Unknown***
SITE LOCATION:	***Town of East Fishkill, Dutchess Co., NY***	DRILLER:	***Unknown***
JOB NO.:	***01003.11.0114***	RIG TYPE:	***Unknown***
LOGGED BY:	***Lithology based on interpretation of USGS Geophysical Log***	DRILLING METHOD:	***Unknown***
		DEVELOPMENT DATE:	***Unknown***
DATES DRILLED:	***Unknown***	LOCATION:	***134 Townsend Road, in back of house***

NOTES:TOC Elevation: 286.10 ft amsl

SURFACE ELEVATION: 285 ft amsl

NORTHING: To Be Determined EASTING: To Be Determined

DEPTH FEET	CUM. BLOWN YIELD	VOC (ppm)	LITHOLOGY
0	NA		
25			
50			DOLOSTONE
			WATERBEARING ZONE: 70 ft
75			DOLOSTONE
100	NA		
125			SHALE: Shale/interbedded shale and dolostone/shaly dolostone
150			
175			
200	NA		
225			
250			WATERBEARING ZONE: 265 ft
275			SHALE: Shale/interbedded shale and dolostone/shaly dolostone
			WATERBEARING ZONE: 270 ft
300	NA		QUARTZITE
325			WATERBEARING ZONE: 288 ft
	NA		QUARTZITE
350			WATERBEARING ZONE: 320 ft
			QUARTZITE
375			
400			



WELL CONSTRUCTION DETAILS

6" locking well cap

6" dia. steel casing +1.1' to 49.5'

6" dia. borehole,
49.5' to 334'

A-2c: Converted Residential Well USGS Geophysical Logs

BOREHOLE GEOPHYSICAL LOG

English/Metric units E

SiteID (C1) 413136073472301
Station name (C12) Du 3259
Other ID BRB-006
Log date 10/20/2009

County Dutchess
State New York
Project CCW00
Recorded by JAA
Observed by JDB

Location description Well on south side of house
Owner

Latitude 41 31 36.4
Longitude 073 47 23.2
Lat/Long datum NAD83
Log measurement point (LMP) LS

Height LMP 0.0
Altitude LMP 375
Altitude datum NGVD29
Description of LMP Land surface

Borehole depth 235
Borehole diameter 6
Casing bottom 39.5
Casing diameter 6
Casing type steel

Source of data USGS
Logging unit Troy
Log orientiation MN
Magnetic declination

Software non-ASCII logs
Fluid type water
Fluid depth below LMP 29.09
at time 13:44

Hydrologic conditions ambient, pump 1.1gal/min, start pump at 13:44 stop pump at 14:47, drawdown= 2.99ft
Type of log ZZ

Tool manufacturer and model, tool serial number, log date and time, logging direction and speed, depth error after logging, log parameter(s) and date(s) of calibration check

Tool run 1 Century 9042-858, 08:51, log down 20 ft/min, depth error= 0.06 ft, gamma and ambient fluid temp and cond- fluid temp and cond cal check 10/15/2009.

Tool run 2 Century 9800-1106, 09:27, log up 9ft/min, depth error= 0.21ft, acoustic image and deviation- in hole cal check.

Tool run 3 Mount Sopris -OBI-MK4, 073612, 11:00, log up 10 ft/min, depth error= 0.18ft, optical image and deviation- in hole cal check

Tool run 4 Mount Sopris - HPFM, HFP2293, 12:38, log down stationary measurments, ambient heat pulse flowmeter

Tool run 5 Mount Sopris - HPFM, HFP2293, 14:47, log up stationary measurments, depth error= 0.25ft, pumping heat pulse flowmeter - in hole cal check.

Tool run 6 Century 9042-858, 13:40, log down 20 ft/min, depth error= 0.20 ft, gamma and pumping fluid temp and cond

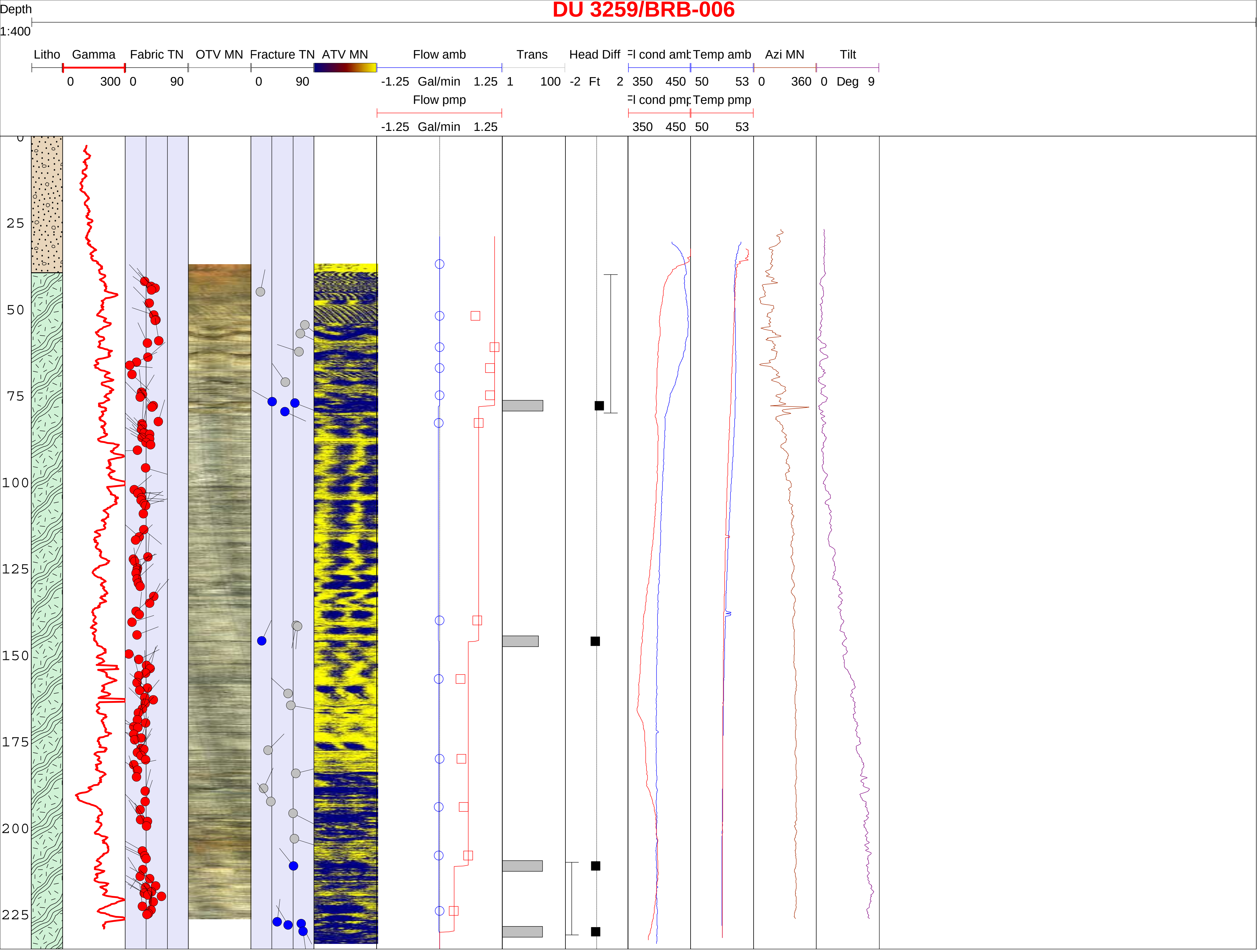
Tool run 7

Tool run 8

Tool run 9

Remarks Casing stickup = 1.0ft above land surface.
Altitude from topo.

DU 3259/BRB-006



BOREHOLE GEOPHYSICAL LOG

English/Metric units E

SiteID (C1) 413136073472701
Station name (C12) Du-3264
Other ID BRB-007
Log date 10/28/2009

County Dutchess
State New York
Project CCW00
Recorded by JAA
Observed by JDB

Location description Well in back yard
Owner Ground Water Science

Latitude 41 31 36.1
Longitude 073 47 26.5
Lat/Long datum NAD83
Log measurement point (LMP) LS

Height LMP 0.0
Altitude LMP 425
Altitude datum NGVD29
Description of LMP Land surface

Borehole depth 235
Borehole diameter 6
Casing bottom 28
Casing diameter 6
Casing type steel

Source of data USGS
Logging unit Troy
Log orientiation MN
Magnetic declination

Software non-ASCII logs
Fluid type water
Fluid depth below LMP 3.62
at time 13:02

Hydrologic conditions ambient, pump 1.0 gal/min, start pump at 13:30, stop pump at 15:05, drawdown= 3.04ft
Type of log ZZ

Tool manufacturer and model, tool serial number, log date and time, logging direction and speed, depth error after logging, log parameter(s) and date(s) of calibration check

Tool run 1 Century 9065, 574, 09:33, log up 20 ft/min, depth error= 0.20ft, caliper cal check 10/28/2009.

Tool run 2 Century 9042-858, 09:55, log down 25 ft/min, depth error= 0.05ft, gamma and ambient fluid temp and cond- fluid temp and cond cal check 10/27/2009.

Tool run 3 Century 9800-1106, 10:23, log up 10 ft/min, depth error= 0.19ft, acoustic image and deviation- in hole cal check.

Tool run 4 Mount Sopris -OBI-MK4, 073612, 11:18, log down 9 ft/min, depth error= 0.2ft, optical image and deviation- in hole cal check

Tool run 5 Mount Sopris - HPFM, HFP2293, 12:07, log down stationary measurments, ambient heat pulse flowmeter

Tool run 6 Mount Sopris - HPFM, HFP2293, 13:54, log up stationary measurments, depth correction= 0.20ft, pumping heat pulse flowmeter - in hole cal check.

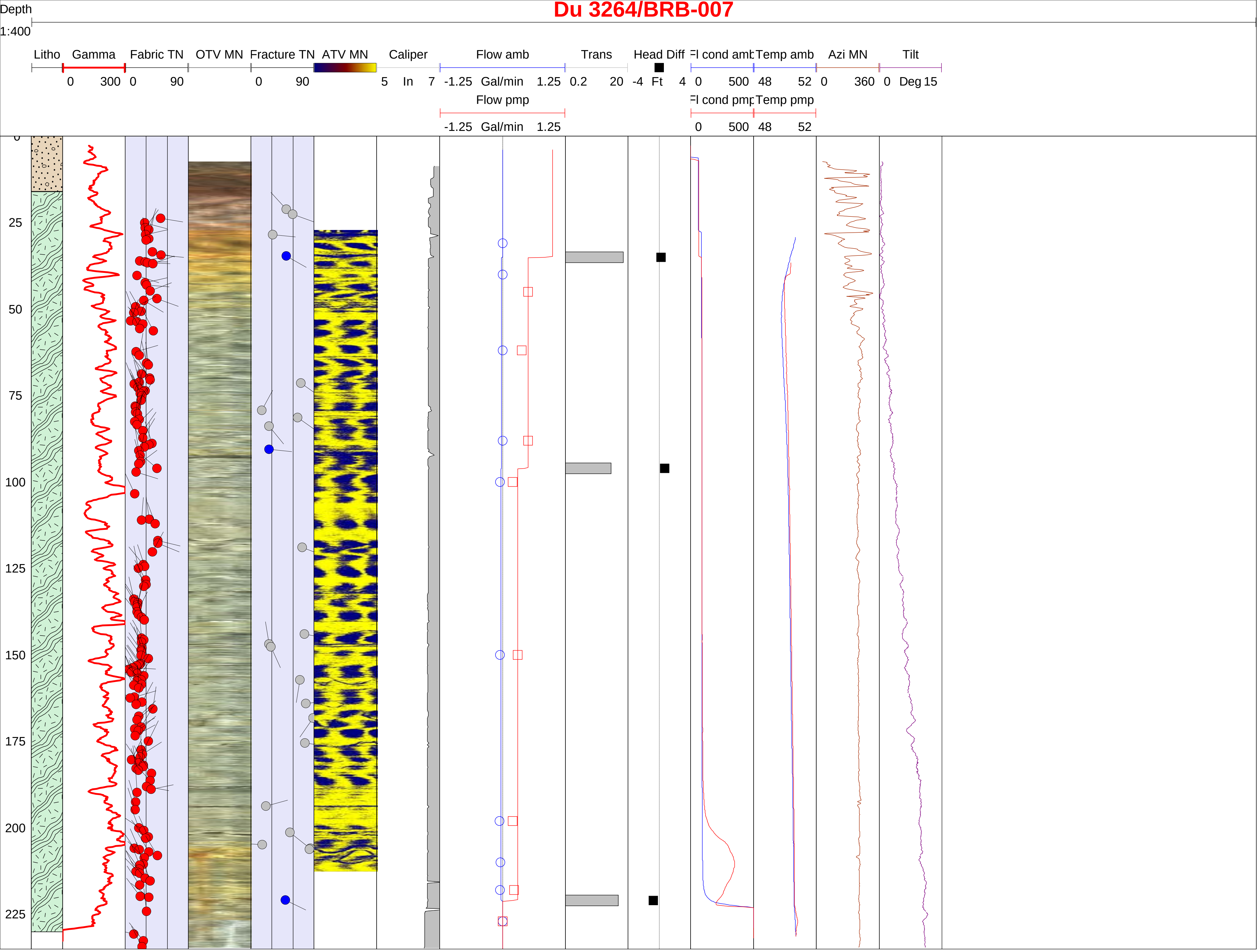
Tool run 7 Century 9042-858, 14:29, log down 25 ft/min, depth error= 0.12 ft, gamma and pumping fluid temp and cond

Tool run 8

Tool run 9

Remarks Casing stickup = 1.0ft above land surface.
Altitude from topo.

Du 3264/BRB-007



USGS
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BOREHOLE GEOPHYSICAL LOG

English/Metric units E

SiteID (C1) 413139073472801 | **Station name (C12)** Du-3263 | **Other ID** BRB 009 | **Log date** 10/27/2009

County Dutchess | **State** New York | **Project** CCW00 | **Recorded by** JAA | **Observed by** JDB

Location description Well in back yard | **Owner**

Latitude 41 31 38.7 | **Longitude** 073 47 27.7 | **Lat/Long datum** NAD83 | **Log measurement point (LMP)** LS

Height LMP 0.0 | **Altitude LMP** 450 | **Altitude datum** NGVD29 | **Description of LMP** Land surface

Borehole depth 308 | **Borehole diameter** 6 | **Casing bottom** 18.5 | **Casing diameter** 6 | **Casing type** steel

Source of data USGS | **Logging unit** Troy | **Log orientiation** MN | **Magnetic declination** -13.5

Software non-ASCII logs | **Fluid type** water | **Fluid depth below LMP** 10.80 | **at time** 15:09

Hydrologic conditions ambient, pump 1.0-0.5-0.3gal/min, start pump at 15:28 stop pump at 16:04, drawdown= 6.51ft. flow measurments made during recovery rate of 0.11gal/min | **Type of log** ZZ

Tool manufacturer and model, tool serial number, log date and time, logging direction and speed, depth error after logging, log parameter(s) and date(s) of calibration check

Tool run 1 Century 9065, 574, 09:27, log up 25 ft/min, depth error= 0.14ft, wellbore cal check 10/21/2009.

Tool run 2 Century 9042-858, 10:42, log down 20 ft/min, depth error= 0.03ft, gamma and ambient fluid temp and cond- fluid temp and cond cal check 10/26/2009.

Tool run 3 Century 9800-1106, 10:07, log up 10 ft/min, depth error= 0.24ft, acoustic image and deviation- in hole cal check.

Tool run 4 Mount Sopris -OBI-MK4, 073612, 12:03, log down 10 ft/min, depth error= 0.05ft, optical image and deviation- in hole cal check

Tool run 5 Mount Sopris - HPFM, HFP2293, 13:29, log down stationary measurments, ambient heat pulse flowmeter

Tool run 6 Mount Sopris - HPFM, HFP2293, 13:34, 15:50 log up stationary measurments, depth correction= 0.14ft, pumping/recovery heat pulse flowmeter - in hole cal check.

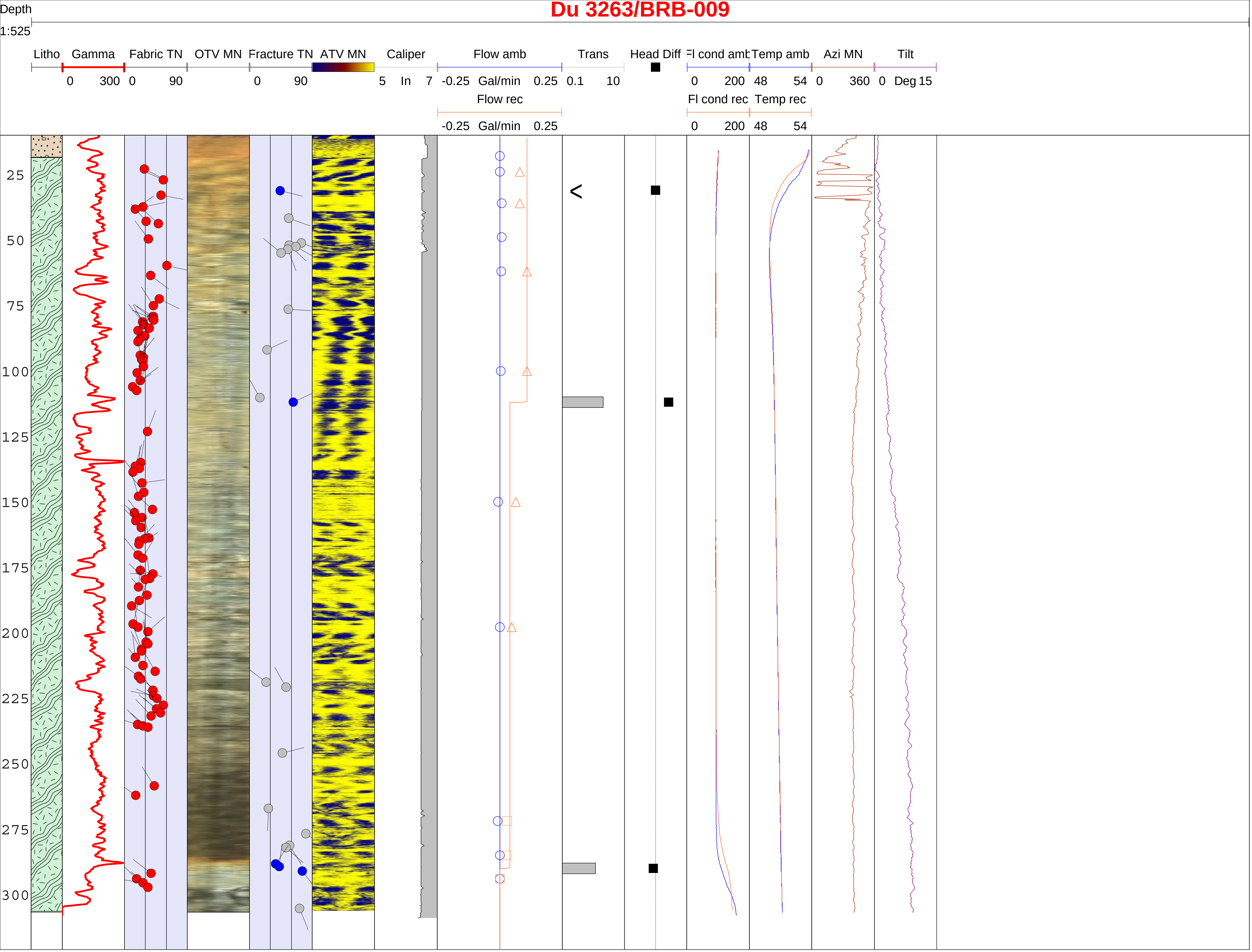
Tool run 7 Century 9042-858, 16:41, log down 20 ft/min, depth error= 0.10 ft, gamma and recovery fluid temp and cond

Tool run 8

Tool run 9

Remarks Casing stickup = 1.2ft above land surface.
Altitude from topo.

Du 3263/BRB-009



BOREHOLE GEOPHYSICAL LOG

English/Metric units E

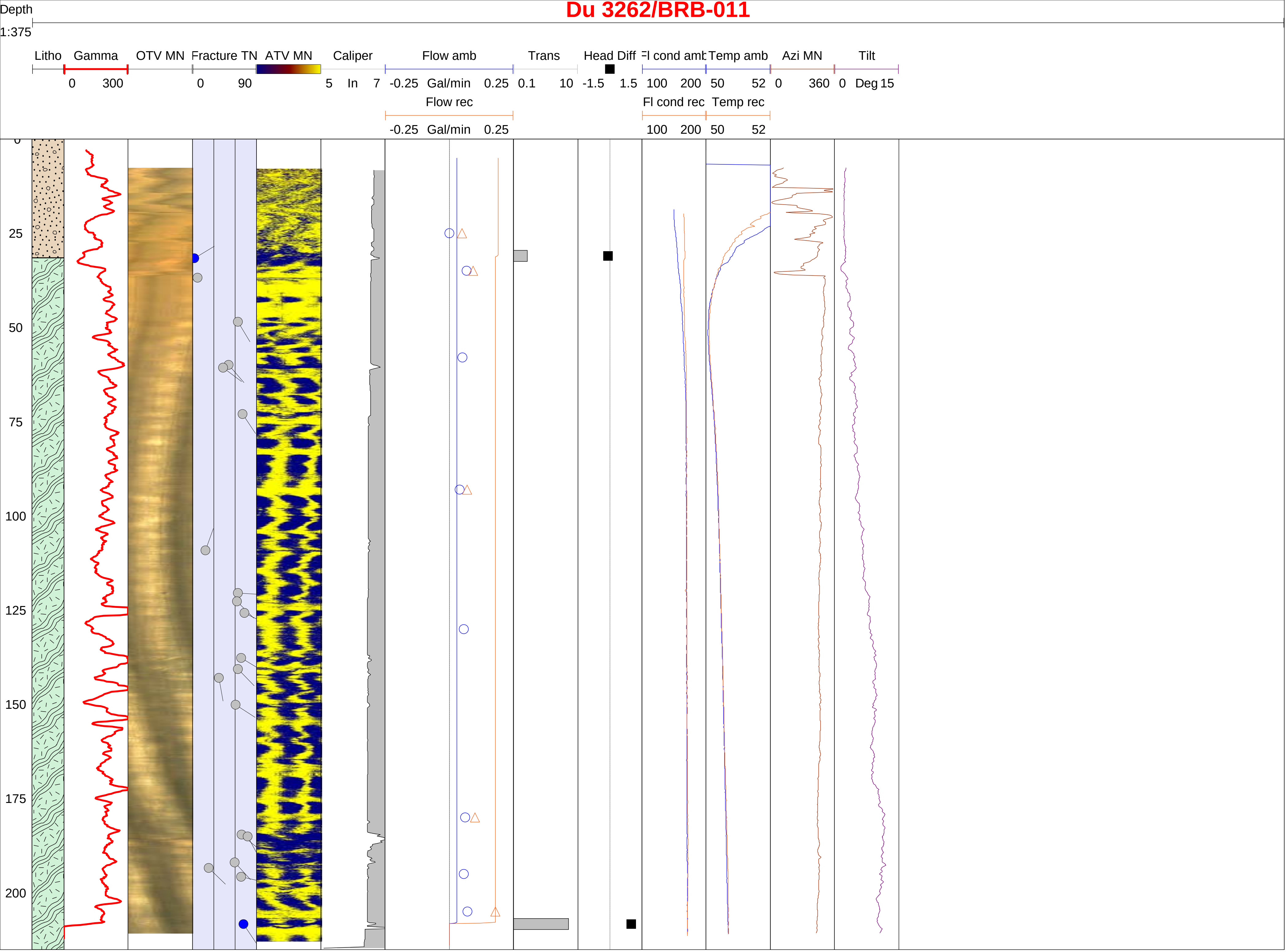
SiteID (C1) 413139073472701	**Station name (C12)** Du 3262	**Other ID** BRB 011	**Log date** 10/26/2009
County Dutchess	**State** New York **Project** CCW00	**Recorded by** JAA	**Observed by** JDB
Location description Well in back yard		**Owner**	
Latitude 41 31 38.5	**Longitude** 073 47 26.6	**Lat/Long datum** NAD83	**Log measurement point (LMP)** LS
Height LMP 0.0	**Altitude LMP** 435	**Altitude datum** NGVD29	**Description of LMP** Land surface
Borehole depth 214.7 **Borehole diameter** 6	**Casing bottom** 31.5	**Casing diameter** 6	**Casing type** steel
Source of data USGS	**Logging unit** Troy	**Log orientiation** MN	**Magnetic declination**
Software non-ASCII logs	**Fluid type** water	**Fluid depth below LMP** 4.66	**at time** 13:02
Hydrologic conditions ambient, pump 1.0gal/min, start pump at 13:11 stop pump at 13:38, drawdown= 7.94ft flowmeter measurments made during recovery rate of 0.1gal/min		**Type of log** ZZ	

Tool manufacturer and model, tool serial number, log date and time, logging direction and speed, depth error after logging, log parameter(s) and date(s) of calibration check

Tool run 1	Century 9065, 574, 11:27, log up 20ft/min, depth error= 0.24ft, caliper cal check 10/21/2009.
Tool run 2	Century 9042-858, 11:43, log down 20 ft/min, depth error= 0.04 ft, gamma and ambient fluid temp and cond- fluid temp and cond in hole cal check.
Tool run 3	Century 9800-1106, 12:48, log up 10 ft/min, depth error= 0.35ft, acoustic image and deviation- in hole cal check.
Tool run 4	Mount Sopris -OBI-MK4, 073612, 13:28, log up 6 ft/min, depth error= 0.12ft, optical image and deviation- in hole cal check
Tool run 5	Mount Sopris - HPFM, HFP2293, 14:11, log down stationary measurments, ambient heat pulse flowmeter
Tool run 6	Mount Sopris - HPFM, HFP2293, 15:26, log up stationary measurments, depth error= 0.08ft, pumping heat pulse flowmeter - in hole cal check.
Tool run 7	Century 9042-858, 15:58, log down 20 ft/min, depth error= 0.0 ft, gamma and recovery fluid temp and cond
Tool run 8	
Tool run 9	

Remarks Casing stickup = 1.2ft above land surface.
Altitude from topo.

Du 3262/BRB-011



BOREHOLE GEOPHYSICAL LOG

English/Metric units E

SiteID (C1) 413139073472101	**Station name (C12)** Du 3251	**Other ID** BRB-014		**Log date** 9/3/2009
County Dutchess	**State** New York	**Project** CCW00	**Recorded by** JAA	**Observed by** RJR
Location description			**Owner**	
Latitude 41 31 39.3	**Longitude** 073 47 21.1	**Lat/Long datum** NAD83	**Log measurement point (LMP)** LS	
Height LMP 0.0	**Altitude LMP** 368	**Altitude datum** NGVD29	**Description of LMP** Land surface	
Borehole depth 199	**Borehole diameter** 6	**Casing bottom** 31	**Casing diameter** 6	**Casing type** steel
Source of data USGS	**Logging unit** Troy	**Log orientiation** MN	**Magnetic declination** -13.5	
Software non-ASCII logs	**Fluid type** water	**Fluid depth below LMP** 20.84	**at time** 14:11	
Hydrologic conditions ambient, pump 0.8gal/min, start pump at 14:12 stop pump at 16:36 . drawdown= 3.71ft		**Type of log** ZZ		

Tool manufacturer and model, tool serial number, log date and time, logging direction and speed, depth error after logging, log parameter(s) and date(s) of calibration check

Tool run 1 Century 9065-715, 09:15, log up 20ft/min, depth error= 0.12ft, caliper in-hole cal check.

Tool run 2 Century 9042-858, 09:35, log down 20 ft/min, depth error= 0.01 ft, gamma and ambient fluid temp/cond

Tool run 3 Century 9801-1106, 10:13, log up 9 ft/min, depth error= 0.19ft, acoustic image and deviation

Tool run 4 Mount Sopris - 073612, 11:05, log up 6 ft/min,depth error= 0.0ft, optical image and deviation

Tool run 5 Century 9721-1162, stationary , 12:10, depth error= 0.17ft, ambient fluid flow -in-hole cal check

Tool run 6 Century 9721-1162, stationary , 14:32, depth error= 0.11ft, pump fluid flow -in-hole cal check

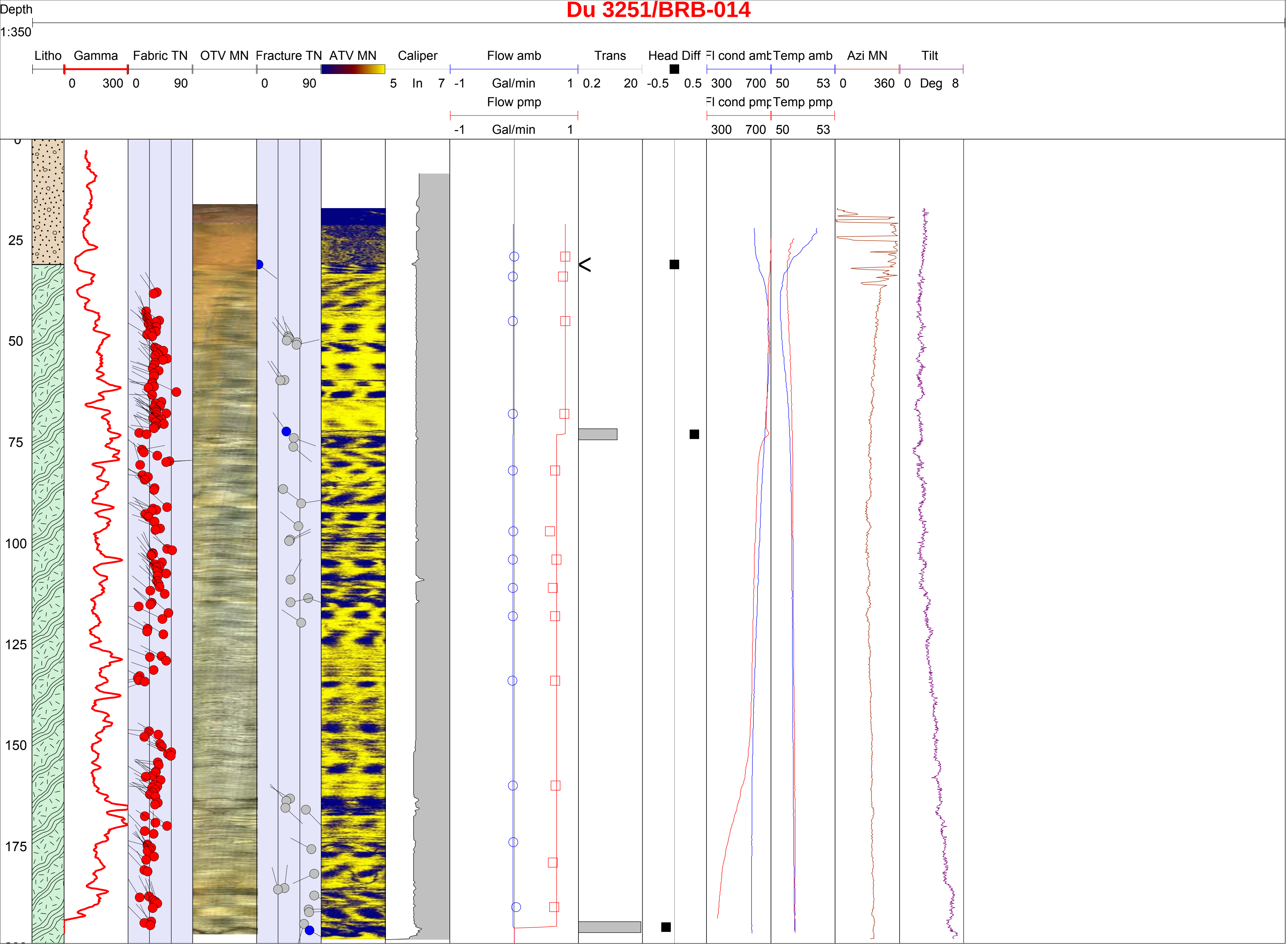
Tool run 7 Century 9042-858, 15:39 log down 20 ft/min, depth error= 0.0 ft, gamma and pumping fluid temp

Tool run 8

Tool run 9

Remarks Casing stickup = 0.8ft,
Altitude from topo

Du 3251/BRB-014



BOREHOLE GEOPHYSICAL LOG

English/Metric units E

SiteID (C1) 413144073473001	**Station name (C12)** Du 3255	**Other ID** EHC-002	**Log date** 10/14/2009
County Dutchess	**State** New York	**Project** CCW00	**Recorded by** JAA **Observed by** RJR
Location description Well in front yard		**Owner**	
Latitude 41 31 44.7	**Longitude** 073 47 30.6	**Lat/Long datum** NAD83	**Log measurement point (LMP)** LS
Height LMP 0.0	**Altitude LMP** 390	**Altitude datum** NGVD29	**Description of LMP** Land surface
Borehole depth 277.2	**Borehole diameter** 6	**Casing bottom** 27 **Casing diameter** 6	**Casing type** steel
Source of data USGS	**Logging unit** Troy	**Log orientiation** MN	**Magnetic declination** -13.5
Software non-ASCII logs	**Fluid type** water	**Fluid depth below LMP** 27.21	**at time** 14.52
Hydrologic conditions ambient, pump 0.8gal/min, start pump at 14:53 stop pump at 17:13, drawdown= 7.13ft		**Type of log** ZZ	

Tool manufacturer and model, tool serial number, log date and time, logging direction and speed, depth error after logging, log parameter(s) and date(s) of calibration check

Tool run 1 Century 9065, 715, 09:01, log up 20ft/min, depth error= 0.07ft, caliper cal check -in hole cal check.

Tool run 2 Century 9042-858, 09:27, log down 20 ft/min, depth error= 0.03 ft, gamma and ambient fluid temp and cond

Tool run 3 Century 9800-1106, 10:06, log up 9 ft/min, depth error= 0.30ft, acoustic image and deviation- in hole cal check.

Tool run 4 Mount Sopris -OBI-MK4, 073612, 11:54, log up 6 ft/min, depth error= 0.20ft, optical image and deviation- in hole cal check

Tool run 5 Mount Sopris - HPFM, HFP2293, 12:50, log down stationary measurments, ambient heat pulse flowmeter

Tool run 6 Mount Sopris - HPFM, HFP2293, 15:37, log up stationary measurments, depth error= 0.01ft, pumping heat pulse flowmeter - in hole cal check.

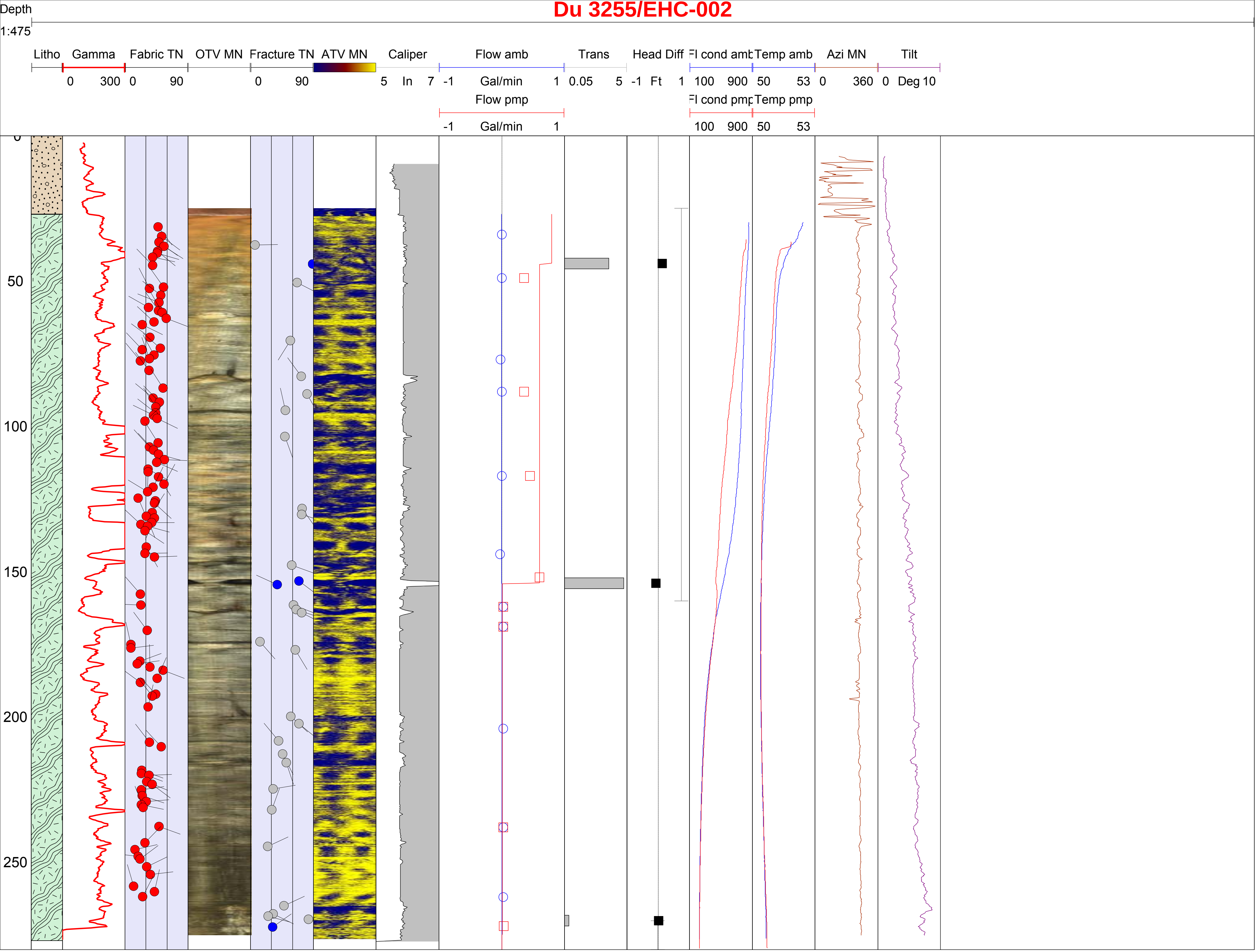
Tool run 7 Century 9042-858, 14:29, log down 25 ft/min, depth error= 0.12 ft, gamma and pumping fluid temp and cond

Tool run 8

Tool run 9

Remarks Casing stickup = 1.3ft above land surface. Ambient water sample at 110ft collected at 10:50 and 220ft at 11:15, pump sample at 148ft collected at 17:05.
Altitude from topo.

Du 3255/EHC-002



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BOREHOLE GEOPHYSICAL LOG

English/Metric units E

SiteID (C1) 413143073474101	**Station name (C12)** Du 3254	**Other ID** GRF-007		**Log date** 10/13/2009
County Dutchess	**State** New York	**Project** CCW00	**Recorded by** JAA	**Observed by** RJR
Location description Well in front yard			**Owner**	
Latitude 41 31 43.4	**Longitude** 073 47 41.3	**Lat/Long datum** NAD83	**Log measurement point (LMP)** LS	
Height LMP 0.0	**Altitude LMP** 340	**Altitude datum** NGVD29	**Description of LMP** Land surface	
Borehole depth 91.35	**Borehole diameter** 6	**Casing bottom** 22.5	**Casing diameter** 6	**Casing type** steel
Source of data USGS	**Logging unit** Troy	**Log orientiation** MN	**Magnetic declination**	
Software non-ASCII logs	**Fluid type** water	**Fluid depth below LMP** 33.37	**at time** 16:09	
Hydrologic conditions ambient, pump 0.65gal/min, start pump at 16:10 stop pump at 16:33, drawdown= 9.08ft,		**Type of log** ZZ		

Tool manufacturer and model, tool serial number, log date and time, logging direction and speed, depth error after logging, log parameter(s) and date(s) of calibration check

Tool run 1 Century 9065, 715, 13:21, log up 20ft/min, depth error= 0.07ft, caliper- in hole cal chech.

Tool run 2 Century 9042-858, 13:34, log down 20 ft/min, depth error= 0.09 ft, gamma and ambient fluid temp and cond

Tool run 3 Century 9800-1106, 13:59, log up 9 ft/min, depth error= 0.08ft, acoustic image and deviation- in hole cal check.

Tool run 4 Mount Sopris -OBI-MK4, 073612, 14:35, log up 6 ft/min, depth error= 0.02ft, optical image and deviation- in hole cal check

Tool run 5 Mount Sopris - HPFM, HFP2293, 15:06, log down stationary measurments, ambient heat pulse flowmeter

Tool run 6 Mount Sopris - HPFM, HFP2293, 16:47, log up stationary measurments, depth correction= 0.02ft, recovery heat pulse flowmeter - in hole cal check.

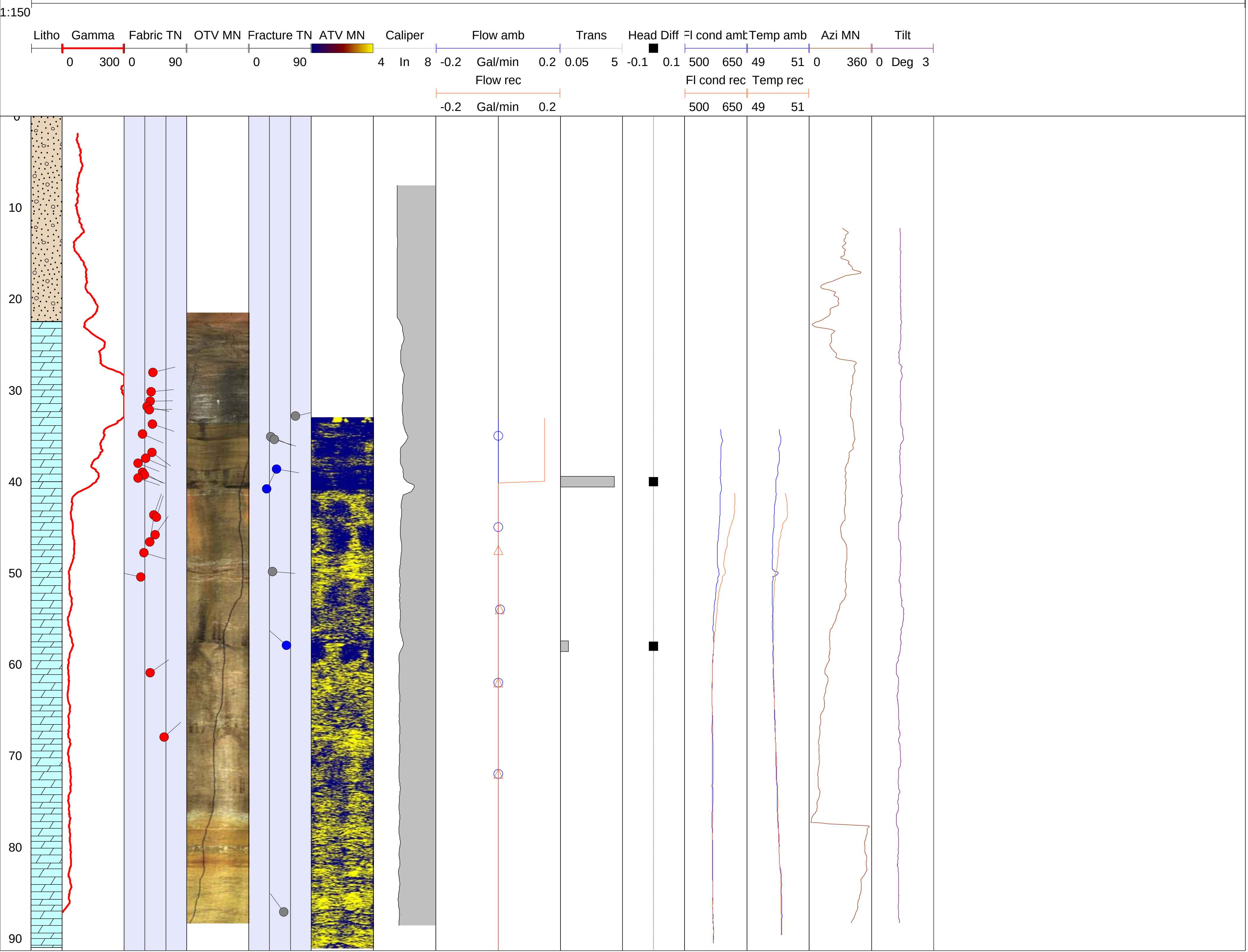
Tool run 7 Century 9042-858, 17:22, log down 20 ft/min, depth error= 0.04 ft, gamma and recovery fluid temp and cond

Tool run 8

Tool run 9

Remarks Casing stickup = 1.85ft above land surface.
Altitude from topo.

Du 3254/GRF-007



BOREHOLE GEOPHYSICAL LOG

English/Metric units E

SiteID (C1) 413159073472901 | **Station name (C12)** Du 3265 | **Other ID** JCK-117 | **Log date** 1/20/2010

County Dutchess | **State** New York | **Project** CCW00 | **Recorded by** JAA | **Observed by** GWS

Location description Well in front yard | **Owner**

Latitude 41 31 58.6 | **Longitude** 073 47 29.4 | **Lat/Long datum** NAD83 | **Log measurement point (LMP)** LS

Height LMP 0.0 | **Altitude LMP** 320 | **Altitude datum** NGVD29 | **Description of LMP** Land surface

Borehole depth 522 | **Borehole diameter** 6 | **Casing bottom** 60 | **Casing diameter** 6 | **Casing type** Steel

Source of data USGS | **Logging unit** Troy | **Log orientiation** MN | **Magnetic declination**

Software non-ASCII logs | **Fluid type** Water | **Fluid depth below LMP** 3.29 **at time** 10:22

Hydrologic conditions Ambient, pump down to 16.56ft for recovery test, recovery rate of 0.1gal/min. | **Type of log** ZZ

Tool manufacturer and model, tool serial number, log date and time, logging direction and speed, depth error after logging, log parameter(s) and date(s) of calibration check

Tool run 1 Century 9065, 574, 1/19/2010 09:06, log up 25ft/min, depth error= 0.37ft, caliper cal check 1/18/2010.

Tool run 2 Century 9042-858, 1/19/2010 09:20, log down 25 ft/min, depth error= 0.02 ft, gamma and ambient fluid temp and cond- fluid temp and cond cal check 1/30/2009.

Tool run 3 Century 9510, 746, 1/19/2010 10:36, log up 25ft/min, depth error= 0.19ft, gamma in CPS and formation conductivity in uS/cm- cond cal 1/18/2010.

Tool run 4 Century 9620, 1046, 1/19/2010 11:17, log up 25ft/min, depth error= .02ft, gamma, mag suscept and dev- mag free air cal check 1/18/2010 and dev tilt test at surface

Tool run 5 Mount Sopris -OBI-MK4, 073612, 1/19/2010 13:00, log up 6 ft/min, depth error= 0.34ft, optical image and deviation- in hole cal check

Tool run 6 Mount Sopris- ABI-40, 3078-020906, 1/19/2010 14:50, log up 5ft/min, depth error = 0.4ft, acoustic image and deviation-in hole cal check.

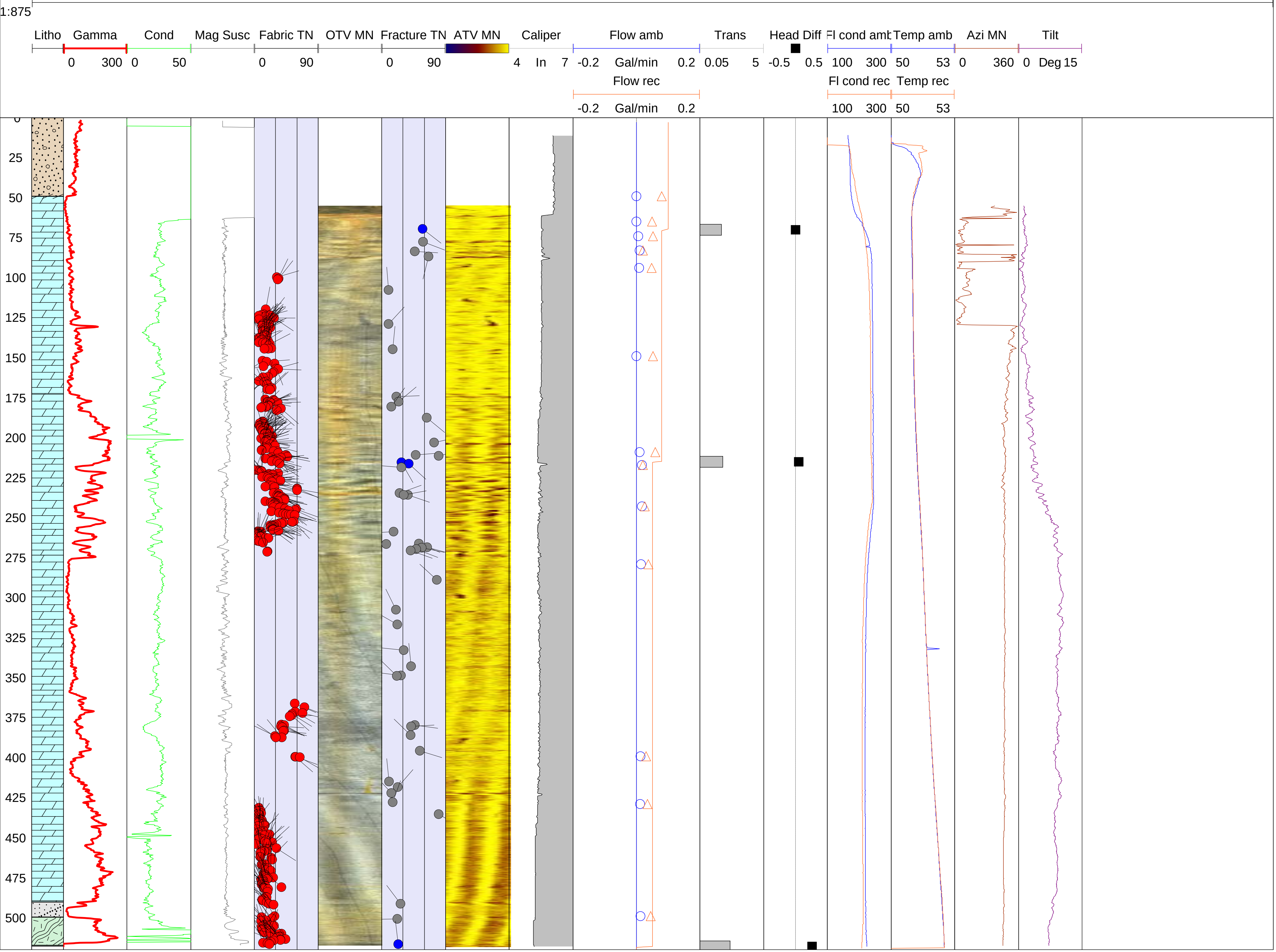
Tool run 7 Mount Sopris - HPFM, HFP2293, 08:10, log down stationary measurments, ambient heat pulse flowmeter

Tool run 8 Mount Sopris - HPFM, HFP2293, 11:12, log up stationary measurments, depth correction= 0.43ft, recovery heat pulse flowmeter - in hole cal check.

Tool run 9 Century 9042-858, 13:08, log down 25 ft/min, depth error= 0.16 ft, recovery fluid temp and cond

Remarks Casing stickup = 2ft above land surface.
Altitude from topo.

Du 3265/JCK-117



BOREHOLE GEOPHYSICAL LOG

English/Metric units E

SiteID (C1) 413139073471901 | **Station name (C12)** Du 3248 | **Other ID** SEY-004 | **Log date** 8/31/2009

County Dutchess | **State** New York | **Project** CCW00 | **Recorded by** JAA | **Observed by** RJR

Location description | **Owner**

Latitude 41 31 38.7 | **Longitude** 073 47 18.8 | **Lat/Long datum** NAD83 | **Log measurement point (LMP)** LS

Height LMP 0.0 | **Altitude LMP** 360 | **Altitude datum** NGVD29 | **Description of LMP** Land surface

Borehole depth 158.8 | **Borehole diameter** 6 | **Casing bottom** 36 | **Casing diameter** 6 | **Casing type** steel

Source of data USGS | **Logging unit** Troy | **Log orientiation** MN | **Magnetic declination** -13.5

Software non-ASCII logs | **Fluid type** water | **Fluid depth below LMP** 10.87 | **at time** 15:58

Hydrologic conditions ambient, pump 1.6 gal/min start pump at 16:02 stop pump at 18:02, drawdown= 4.13ft | **Type of log** ZZ

Tool manufacturer and model, tool serial number, log date and time, logging direction and speed, depth error after logging, log parameter(s) and date(s) of calibration check

Tool run 1 Century 9065-715, 11:58, log up 20ft/min, depth error= 0.17ft, caliper in-hole cal check.

Tool run 2 Century 9620-1046, 8/27/2009 -12:22, log up 20 ft/min, depth error= -0.03, magnetic suscept-gamma-deviation

Tool run 3 Century 9801-1106, 12:50, log up 9 ft/min, depth error= 0.2ft, acoustic image and deviation

Tool run 4 Mount Sopris - 073612, 14:02, log up 6 ft/min,depth error= 0.0ft, optical image and deviation

Tool run 5 Century 9721-1162, 14:17, log down 20ft/min,depth error= 0.07, ambient fluid temp/cond -in-hole cal check

Tool run 6 Century 9721-1162, 14:29, stationary, ambient stationary fluid flow -in-hole cal check

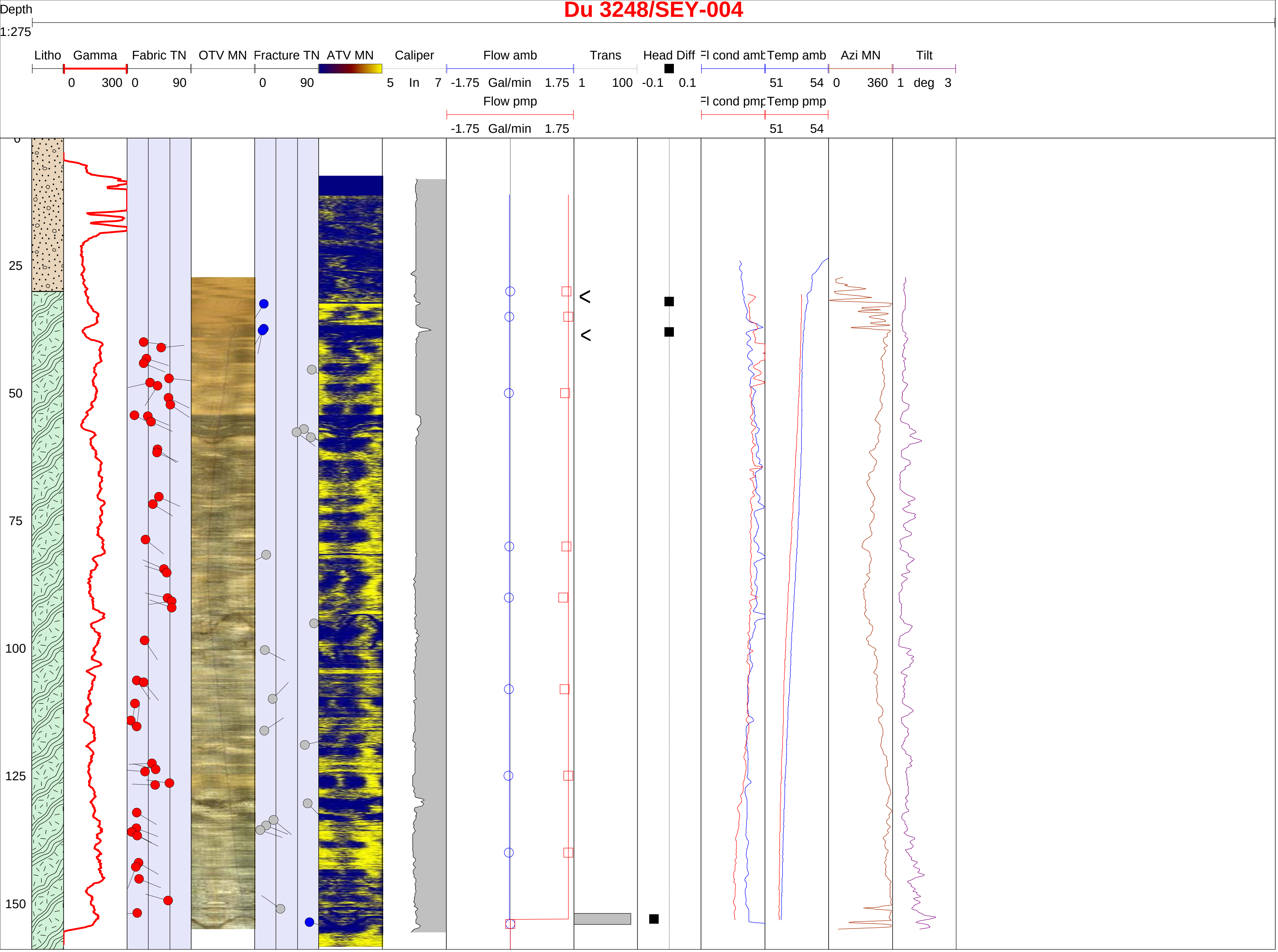
Tool run 7 Century 9721-1162, 16:30, log down 20ft/min, depth error= 0.12ft, pumping fluid temp/cond

Tool run 8 Century 9721-1162, 16:48, stationary , pumping stationary fluid flow -in-hole cal check

Tool run 9

Remarks Casing stickup = 1.2 ft,
Altitude from topo

Du 3248/SEY-004



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BOREHOLE GEOPHYSICAL LOG

English/Metric units E

SiteID (C1) 413137073471601
Station name (C12) Du 3252
Other ID SEY-005
Log date 10/29/2009

County Dutchess
State New York
Project CCW00
Recorded by JAA
Observed by JDB

Location description
Owner

Latitude 41 31 37.4
Longitude 073 47 15.7
Lat/Long datum NAD83
Log measurement point (LMP) LS

Height LMP 0.0
Altitude LMP 345
Altitude datum NGVD29
Description of LMP Land surface

Borehole depth 322
Borehole diameter 6
Casing bottom 51.5
Casing diameter 6
Casing type steel

Source of data USGS
Logging unit Troy
Log orientiation MN
Magnetic declination -13.5

Software non-ASCII logs
Fluid type water
Fluid depth below LMP 3.62
at time 13:02

Hydrologic conditions ambient, pump 1.15gal/min, start pump at 13:11 stop pump at 14:47, drawdown= 3.84ft
Type of log ZZ

Tool manufacturer and model, tool serial number, log date and time, logging direction and speed, depth error after logging, log parameter(s) and date(s) of calibration check

Tool run 1 Century 9065, 574, 09:01, log up 25ft/min, depth error= 0.12ft, caliper cal check 10/21/2009.

Tool run 2 Century 9042-858, 09:20, log down 25 ft/min, depth error= 0.02 ft, gamma and ambient fluid temp and cond- fluid temp and cond in hole cal check.

Tool run 3 Century 9800-1106, 09:57, log up 10 ft/min, depth error= 0.35ft, acoustic image and deviation- in hole cal check.

Tool run 4 Mount Sopris -OBI-MK4, 073612, 11:00, log up 10 ft/min, depth error= 0.18ft, optical image and deviation- in hole cal check

Tool run 5 Mount Sopris - HPFM, HFP2293, 11:53, log down stationary measurments, ambient heat pulse flowmeter

Tool run 6 Mount Sopris - HPFM, HFP2293, 13:34, log up stationary measurments, depth correction= 0.25ft, pumping heat pulse flowmeter - in hole cal check.

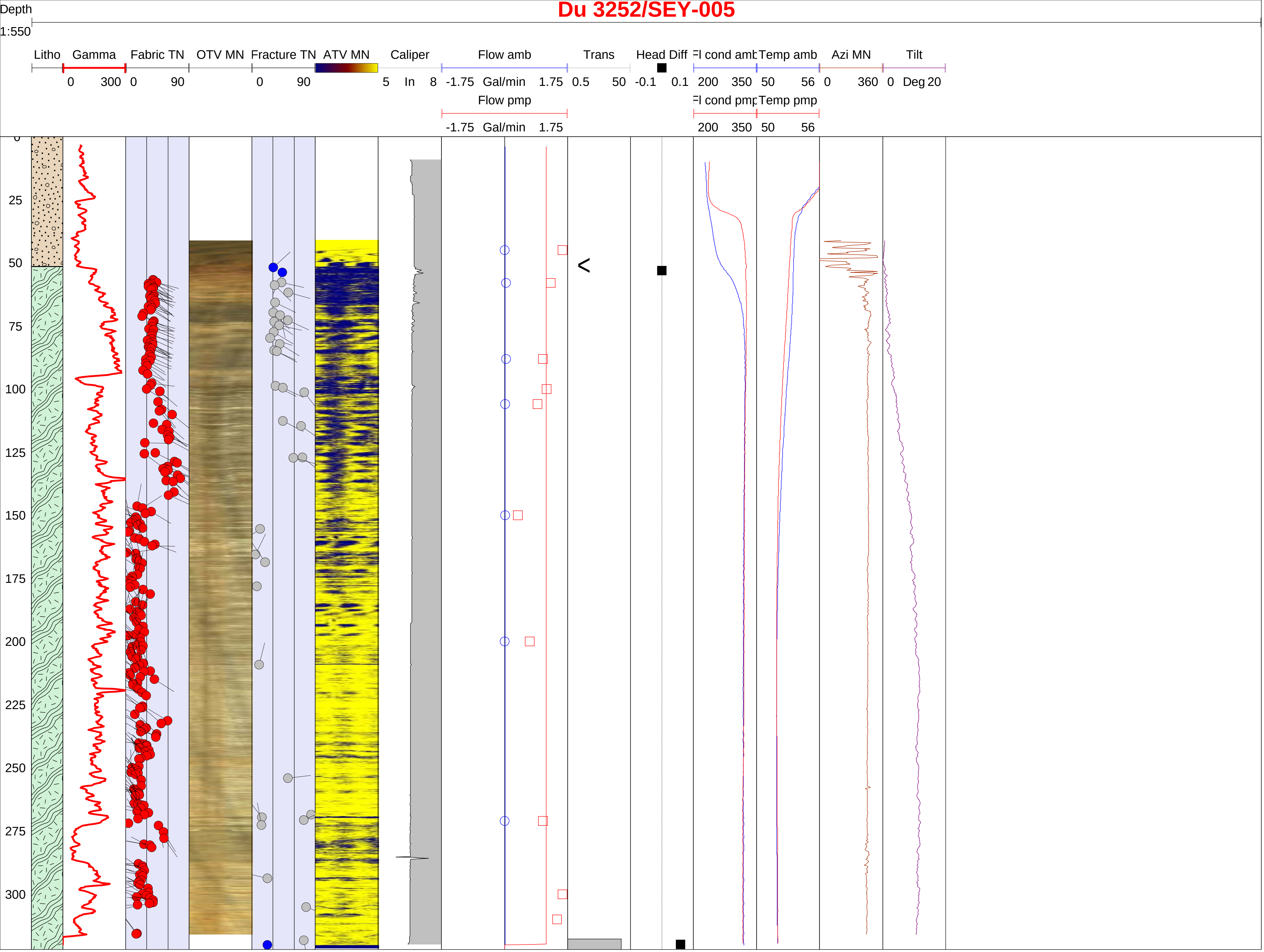
Tool run 7 Century 9042-858, 14:29, log down 25 ft/min, depth error= 0.12 ft, gamma and pumping fluid temp and cond

Tool run 8

Tool run 9

Remarks Casing stickup = 1.2ft above land surface.
Altitude from topo.

Du 3252/SEY-005



BOREHOLE GEOPHYSICAL LOG

English/Metric units E

SiteID (C1) 413137073471901 | **Station name (C12)** Du 3250 | **Other ID** SEY-006 | **Log date** 9/2/2009

County Dutchess | **State** New York | **Project** CCW00 | **Recorded by** JAA | **Observed by** RJR

Location description In back yard behind pool house | **Owner**

Latitude 41 31 37.1 | **Longitude** 073 47 19.4 | **Lat/Long datum** NAD83 | **Log measurement point (LMP)** LS

Height LMP 0.0 | **Altitude LMP** 365 | **Altitude datum** NGVD29 | **Description of LMP** Land surface

Borehole depth 220 | **Borehole diameter** 6 | **Casing bottom** 31 | **Casing diameter** 6 | **Casing type** steel

Source of data USGS | **Logging unit** Troy | **Log orientiation** MN | **Magnetic declination** -13.5

Software non-ASCII logs | **Fluid type** water | **Fluid depth below LMP** 10.29 **at time** 16:00

Hydrologic conditions ambient, pump 1.5gal/min start pump at 16:01 stop pump at 18:05, drawdown= 2.7ft | **Type of log** ZZ

Tool manufacturer and model, tool serial number, log date and time, logging direction and speed, depth error after logging, log parameter(s) and date(s) of calibration check

Tool run 1 Century 9065-715, 09:25, log up 20ft/min, depth error= 0.1ft, caliper in-hole cal check.

Tool run 2 Century 9620-1046, 0953, log up 20 ft/min, depth error= 0.08, magnetic suscept-gamma-deviation

Tool run 3 Century 9801-1106, 10:25, log up 9 ft/min, depth error= 0.24ft, acoustic image and deviation

Tool run 4 Mount Sopris - 073612, 11:40, log up 6 ft/min,depth error= 0.0ft, optical image and deviation-

Tool run 5 Century 9042-858, 12:59, log down 20 ft/min, depth error= 0.7 ft, ambient gamma and fluid temp/cond

Tool run 6 Century 9721-1162, 13:38, stationary, ambient stationary fluid flow -in-hole cal check

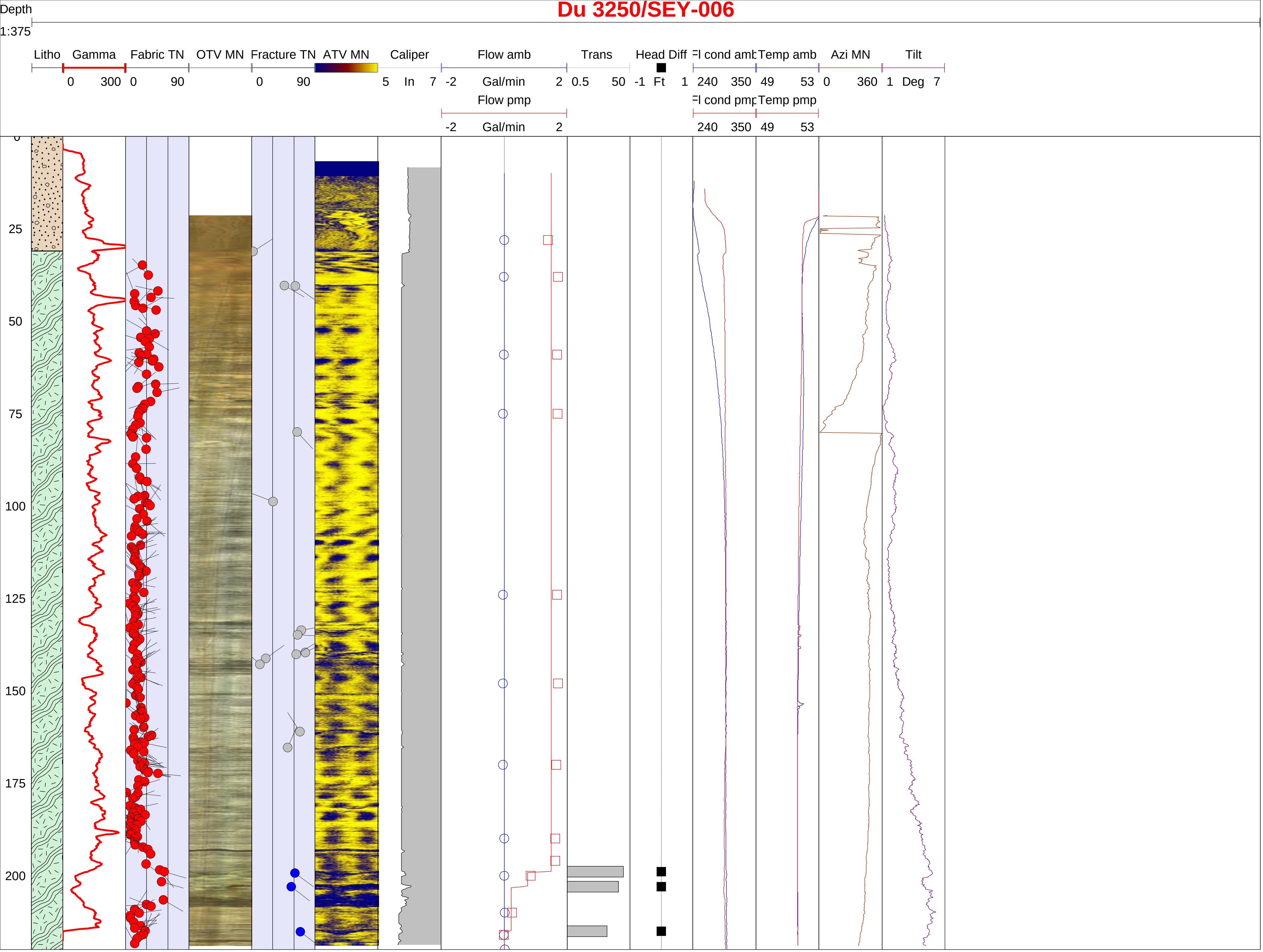
Tool run 7 Century 9721-1162, 16:22, stationary, pumping stationary fluid flow -in-hole cal check

Tool run 8 Century 9042-858, 17:17, log down 20 ft/min, depth error= 0.0 ft, pumping gamma and fluid temp/cond

Tool run 9

Remarks Casing stickup = ft, ambient water sample at 50ft collected at15:00 and at 125ft collected at 15:30, pumped water sample at 185ft collected at 18:00.
Altitude for LMP from topo

Du 3250/SEY-006



BOREHOLE GEOPHYSICAL LOG

English/Metric units E

SiteID (C1) 413137073471601
Station name (C12) Du 3266
Other ID SEY-007
Log date 1/18/2010

County Dutchess
State New York
Project CCW00
Recorded by JAA
Observed by GWS

Location description Well in front yard behind boulder
Owner

Latitude 41 31 36.0
Longitude 073 47 15.9
Lat/Long datum NAD83
Log measurement point (LMP) LS

Height LMP 0.0
Altitude LMP 345
Altitude datum NGVD29
Description of LMP Land surface

Borehole depth 116.5
Borehole diameter 6
Casing bottom 42.5
Casing diameter 6
Casing type Steel

Source of data USGS
Logging unit Troy
Log orientiation MN
Magnetic declination -13.5

Software non-ASCII logs
Fluid type Water
Fluid depth below LMP 5.76
at time 14.47

Hydrologic conditions ambient, pump 1.0gal/min, start pump at 15:30 stop pump at 16:54, drawdown= 2.78ft
Type of log ZZ

Tool manufacturer and model, tool serial number, log date and time, logging direction and speed, depth error after logging, log parameter(s) and date(s) of calibration check

Tool run 1 Century 9065, 715, 11:30, log up 20ft/min, depth error= 0.08ft, caliper - cal 1/18/2010.

Tool run 2 Century 9042, 858, 11:47, log down 20 ft/min, depth error= 0.04ft, gamma and ambient fluid temp and cond- fluid temp and cond cal check 10/29/2009

Tool run 3 Century 9510, 746, 12:10, log up 20ft/min, depth error= .08ft, gamma and EM induction- cond cal 1/18/2010.

Tool run 4 Century 9620, 1046, 12:29, log up 20ft/min, depth error= .02ft, gamma, mag suscept and dev- mag free air cal check 1/18/2010 and dev tilt test at surface

Tool run 5 Mount Sopris -OBI-MK4, 073612, 13:00, log up 6 ft/min, depth error= 0.1ft, optical image and deviation- in hole cal check

Tool run 6 Mount Sopris- ABI-40, 3078-020906, 13:37, log up 5ft/min, depth error = 0.04ft, acoustic image and deviation-cal check 12/12/2009.

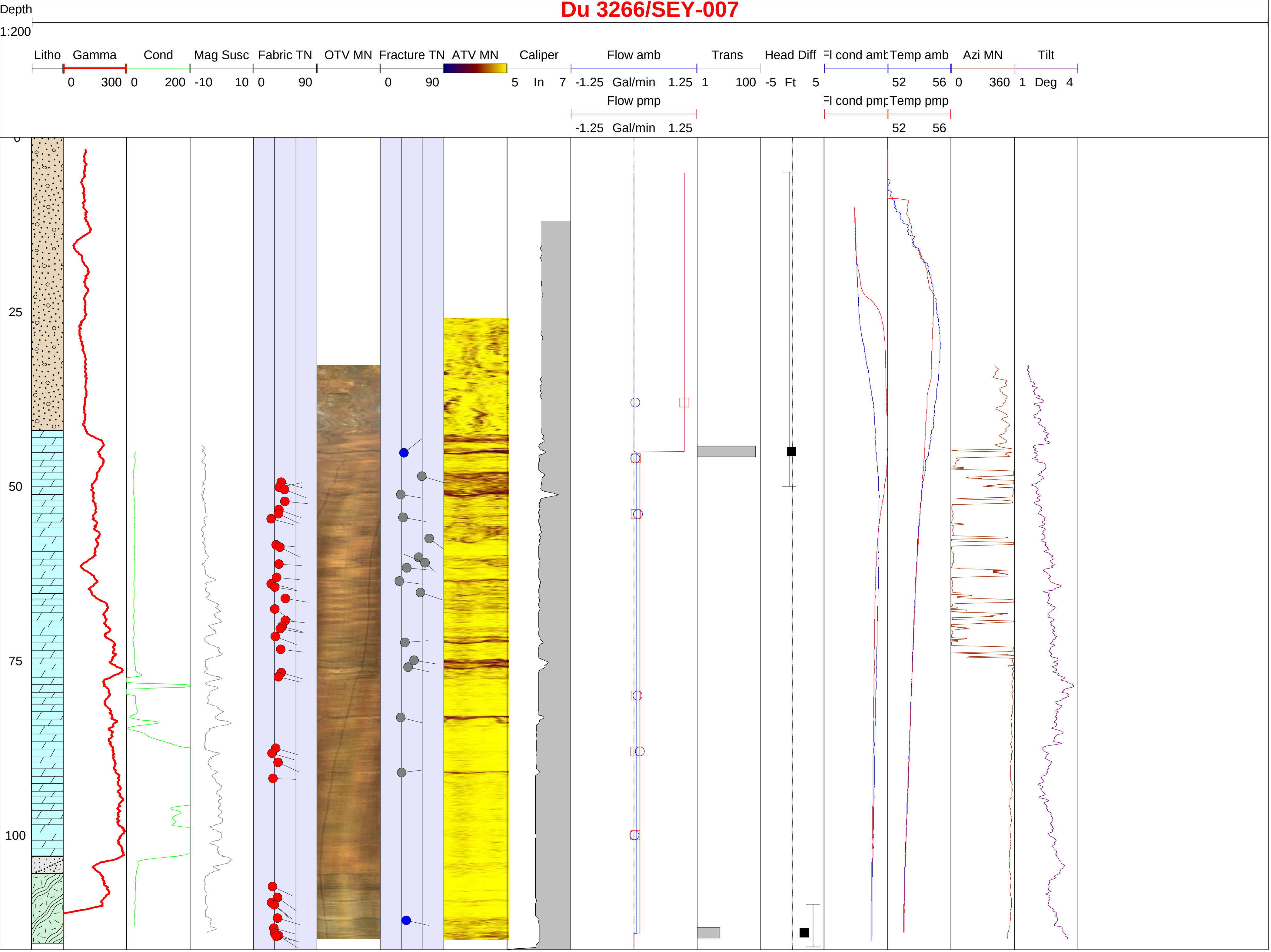
Tool run 7 Mount Sopris - HPFM, HFP2293, 14:07, log down stationary measurments, ambient heat pulse flowmeter

Tool run 8 Mount Sopris - HPFM, HFP2293, 15:47, log up stationary measurments, depth correction= 0.06ft, pumping heat pulse flowmeter - in hole cal check.

Tool run 9 Century 9042-858, 16:29, log down 25 ft/min, depth error= 0.12 ft, gamma and pumping fluid temp and cond

Remarks Stickup= 1.90ft ALS. Ambient sample 70ft at 15:04, pump sample 25ft at 16:35. Altitude from topo.

Du 3266/SEY-007



BOREHOLE GEOPHYSICAL LOG

English/Metric units E

SiteID (C1) 413150079473501	**Station name (C12)** Du 3245	**Other ID** SHN-472		**Log date** 8/25/2009
County Dutchess	**State** New York	**Project** CCW00	**Recorded by** JAA	**Observed by** RJR
Location description in front yard behind evergreens.			**Owner**	
Latitude 41 31 49.5	**Longitude** 073 47 34.9	**Lat/Long datum** NAD83	**Log measurement point (LMP)** LS	
Height LMP 0.0	**Altitude LMP** 340	**Altitude datum** NGVD29	**Description of LMP** Land surface	
Borehole depth 92.1	**Borehole diameter** 6	**Casing bottom** 88.75	**Casing diameter** 6	**Casing type** steel
Source of data USGS	**Logging unit** Troy	**Log orientiation** HS	**Magnetic declination** -13.5	
Software non-ASCII logs		**Fluid type** Water	**Fluid depth below LMP** 19.90	**at time** 15:35
Hydrologic conditions ambient, pump 0.5 gal/min, start pump at 15:48 stop pump at 16:30. drawdown= 8.21ft			**Type of log** ZZ	

Tool manufacturer and model, tool serial number, log date and time, logging direction and speed, depth error after logging, log parameter(s) and date(s) of calibration check

Tool run 1 Century 9065-715, 12:22, log up 20ft/min, depth error= 0.0ft, caliper in-hole cal check.

Tool run 2 Century 9042-858, 12:33, log down 20 ft/min, depth error= 0.0 ft, gamma and ambient fluid temp and cond-in-hole cal check with hand held YSI

Tool run 3 Century 9801-1106, 13:03, log up 9 ft/min, depth error= 0.0ft, acoustic image and deviation

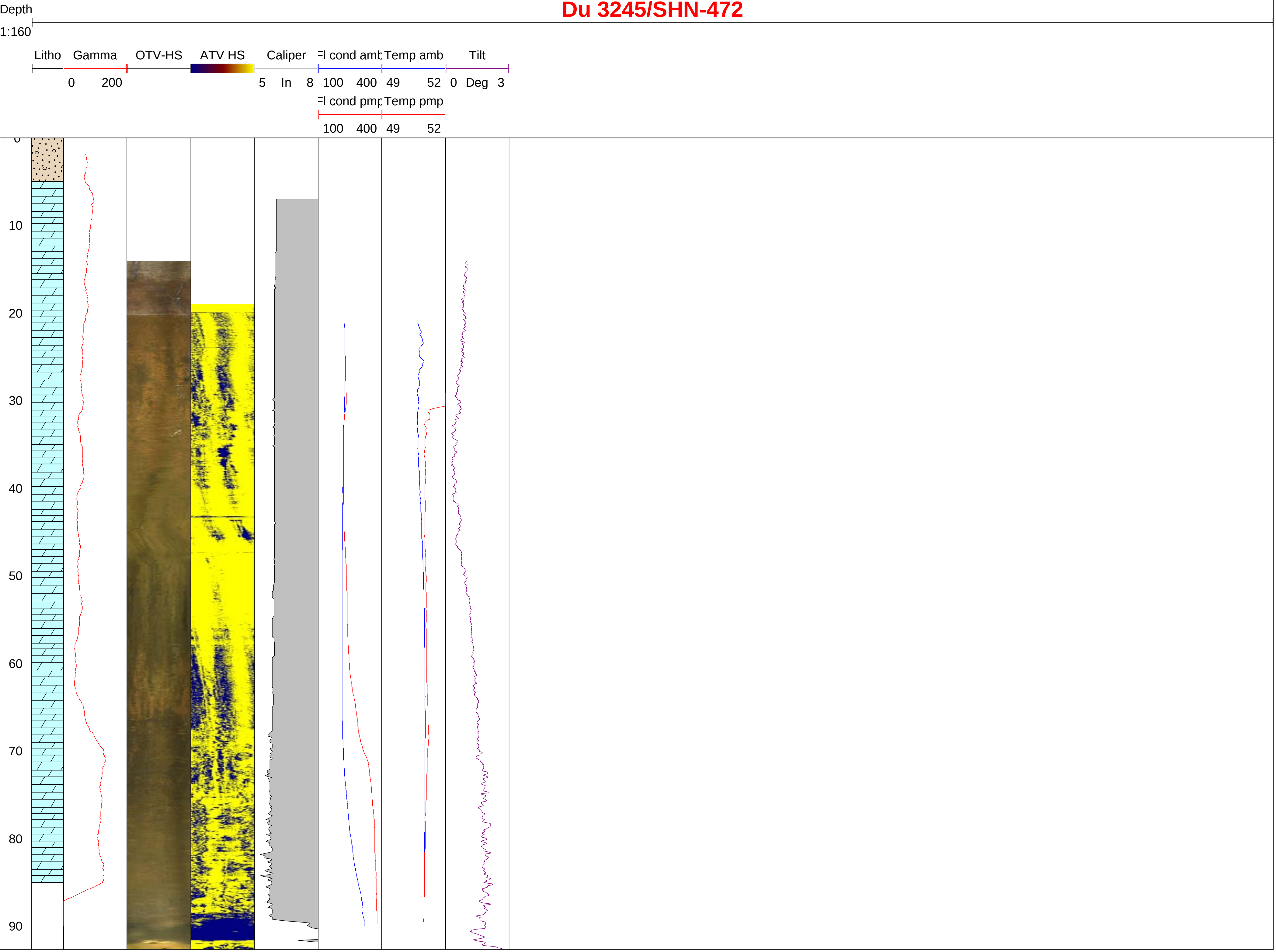
Tool run 4 Mount Sopris - 073612, 14:21, log up 6 ft/min,depth error= 0.0ft, optical image and deviation-tilt test at surface

Tool run 5 Century 9042-858, 14:35, log down 20 ft/min, depth error= 0.0 ft, gamma and pumping fluid temp

Tool run 6

Remarks Casing stickup = 1.8ft..
Altitude from topo.

Du 3245/SHN-472



BOREHOLE GEOPHYSICAL LOG

English/Metric units E

SiteID (C1) 413150079473501	**Station name (C12)** Du 3245	**Other ID** SHN-472		**Log date** 8/25/2009
County Dutchess	**State** New York	**Project** CCW00	**Recorded by** JAA	**Observed by** RJR
Location description in front yard behind evergreens.			**Owner**	
Latitude 41 31 49.5	**Longitude** 073 47 34.9	**Lat/Long datum** NAD83	**Log measurement point (LMP)** LS	
Height LMP 0.0	**Altitude LMP** 340	**Altitude datum** NGVD29	**Description of LMP** Land surface	
Borehole depth 92.1	**Borehole diameter** 6	**Casing bottom** 88.75	**Casing diameter** 6	**Casing type** steel
Source of data USGS	**Logging unit** Troy	**Log orientiation** HS	**Magnetic declination** -13.5	
Software non-ASCII logs	**Fluid type** Water	**Fluid depth below LMP** 19.90	**at time** 15:35	
Hydrologic conditions ambient, pump 0.5 gal/min, start pump at 15:48 stop pump at 16:30. drawdown= 8.21ft		**Type of log** ZZ		

Tool manufacturer and model, tool serial number, log date and time, logging direction and speed, depth error after logging, log parameter(s) and date(s) of calibration check

Tool run 1 Century 9065-715, 12:22, log up 20ft/min, depth error= 0.0ft, caliper in-hole cal check.

Tool run 2 Century 9042-858, 12:33, log down 20 ft/min, depth error= 0.0 ft, gamma and ambient fluid temp and cond-in-hole cal check with hand held YSI

Tool run 3 Century 9801-1106, 13:03, log up 9 ft/min, depth error= 0.0ft, acoustic image and deviation

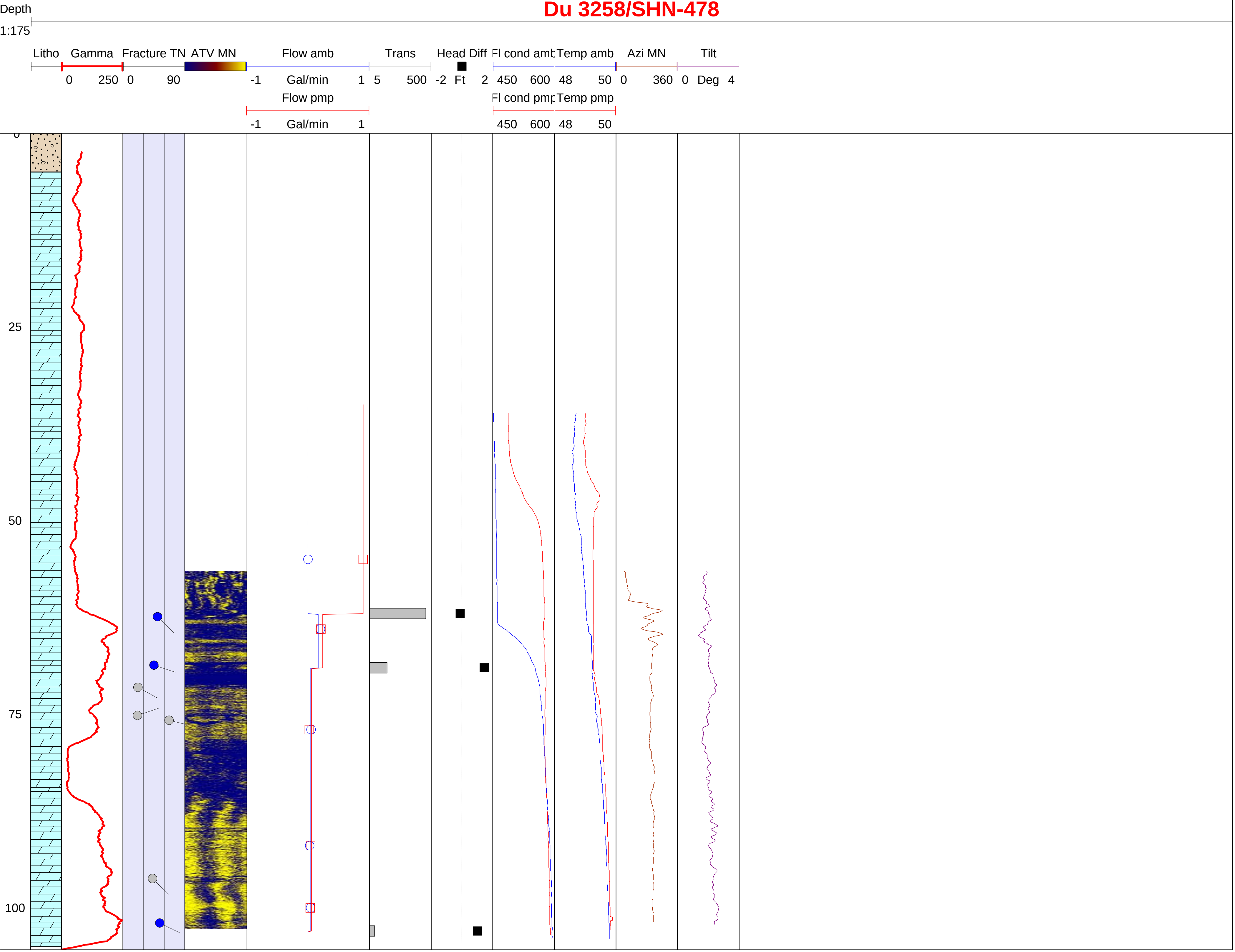
Tool run 4 Mount Sopris - 073612, 14:21, log up 6 ft/min,depth error= 0.0ft, optical image and deviation-tilt test at surface

Tool run 5 Century 9042-858, 14:35, log down 20 ft/min, depth error= 0.0 ft, gamma and pumping fluid temp

Tool run 6

Remarks Casing stickup = 1.8ft..
Altitude from topo.

Du 3258/SHN-478



BOREHOLE GEOPHYSICAL LOG

English/Metric units E

SiteID (C1) 413146073472901 **Station name (C12)** Du 3261 **Other ID** SHN-499 **Log date** 10/22/2009

County Dutchess **State** New York **Project** CCW00 **Recorded by** JAA **Observed by**

Location description Well in front yard **Owner**

Latitude 41 31 45.5 **Longitude** 073 47 28.6 **Lat/Long datum** NAD83 **Log measurement point (LMP)** LS

Height LMP 0.0 **Altitude LMP** 405 **Altitude datum** NGVD29 **Description of LMP** Land surface

Borehole depth 148 **Borehole diameter** 6 **Casing bottom** 23.75 **Casing diameter** 6 **Casing type** steel

Source of data USGS **Logging unit** Troy **Log orientiation** MN **Magnetic declination** -13.5

Software non-ASCII logs **Fluid type** water **Fluid depth below LMP** 32.96 **at time** 12:11

Hydrologic conditions ambient, pump 0.25gal/min, start pump at 12:16 stop pump at 12:34, drawdown= 7.18ft **Type of log** ZZ

Tool manufacturer and model, tool serial number, log date and time, logging direction and speed, depth error after logging, log parameter(s) and date(s) of calibration check

Tool run 1 Century 9065, 574, 08:38, log up 20ft/min, depth error= 0.1ft, caliper cal check 10/21/2009.

Tool run 2 Century 9042-858, 09:00, log down 20ft/min, depth error= 0.05 ft, gamma and ambient fluid temp and cond- fluid temp and cond in hole 10/21/2009.

Tool run 3 Century 9800-1106, 09:28, log up 9ft/min, depth error= 0.07ft, acoustic image and deviation- in hole cal check.

Tool run 4 Mount Sopris -OBI-MK4, 073612, 09:50, log up 6ft/min, depth error= 0.0ft, optical image and deviation- in hole cal check

Tool run 5 Mount Sopris - HPFM, HFP2293, 10:37, log down stationary measurments, ambient heat pulse flowmeter

Tool run 6 Mount Sopris - HPFM, HFP2293, 12:36, log up stationary measurments, depth correction= 0.0ft, recovery heat pulse flowmeter - in hole cal check.

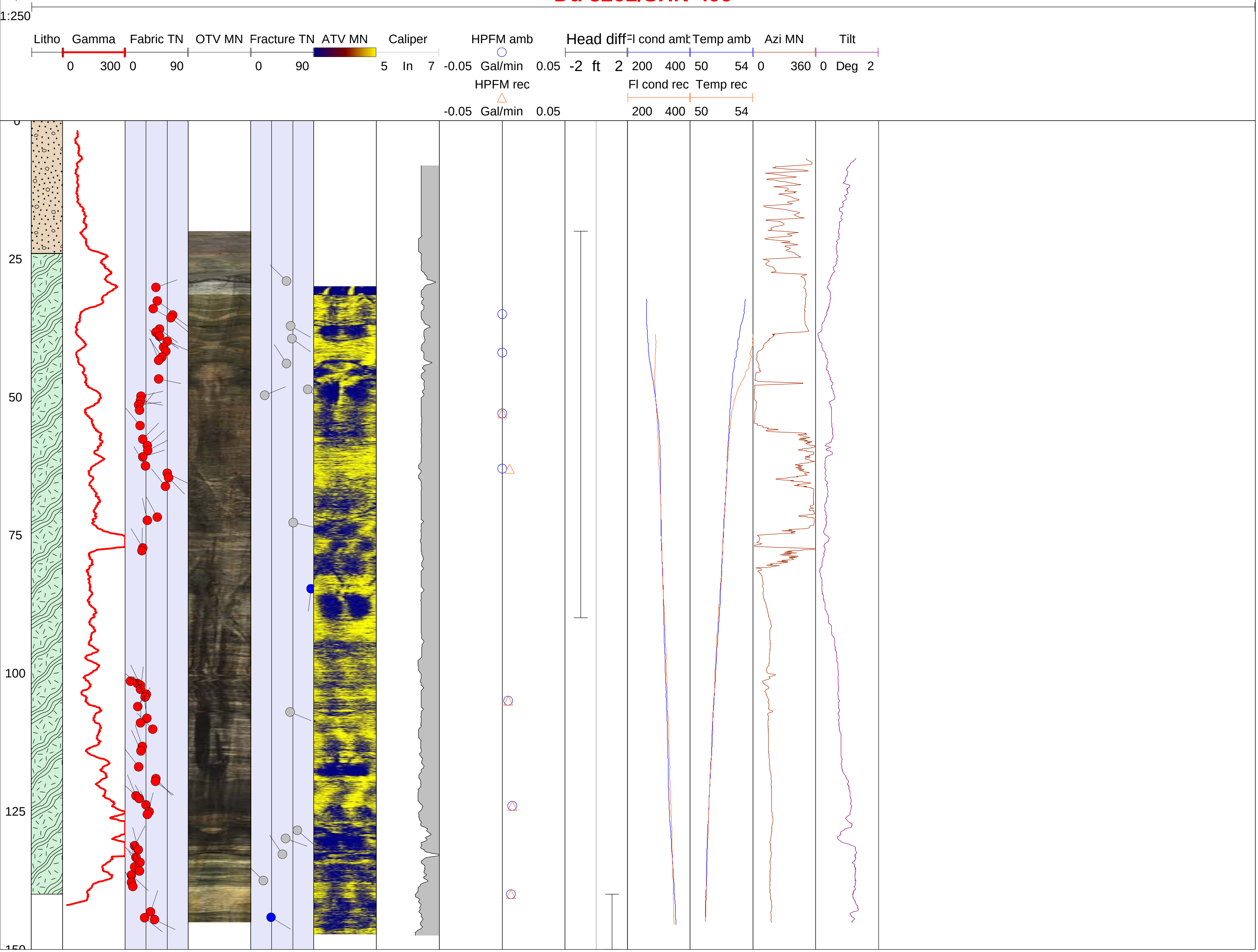
Tool run 7 Century 9042-858, 14:29, log down 25 ft/min, depth error= 0.12 ft, gamma and pumping fluid temp and cond

Tool run 8

Tool run 9

Remarks Casing stickup = 1.7ft above land surface.
Altitude from topo.

Du 3261/SHN-499



USGS
science for a changing world

BOREHOLE GEOPHYSICAL LOG

English/Metric units E

SiteID (C1) 413129073472401	**Station name (C12)** Du 3249	**Other ID** SHN-589	**Log date** 9/1/2009

County Dutchess	**State** New York	**Project** CCW00	**Recorded by** JAA	**Observed by** RJR

Location description Back yard about 20 feet up hill into tree line	**Owner**

Latitude 41 31 28.5	**Longitude** 073 47 23.9	**Lat/Long datum** NAD83	**Log measurement point (LMP)** LS
Height LMP 0.0	**Altitude LMP** 360	**Altitude datum** NGVD29	**Description of LMP** Land surface

Borehole depth 203	**Borehole diameter** 6	**Casing bottom** 19.5	**Casing diameter** 6	**Casing type** steel

Source of data USGS	**Logging unit** Troy	**Log orientiation** MN	**Magnetic declination** -13.5

Software non-ASCII logs	**Fluid type** Water	**Fluid depth below LMP** 3.16	**at time** 14:32

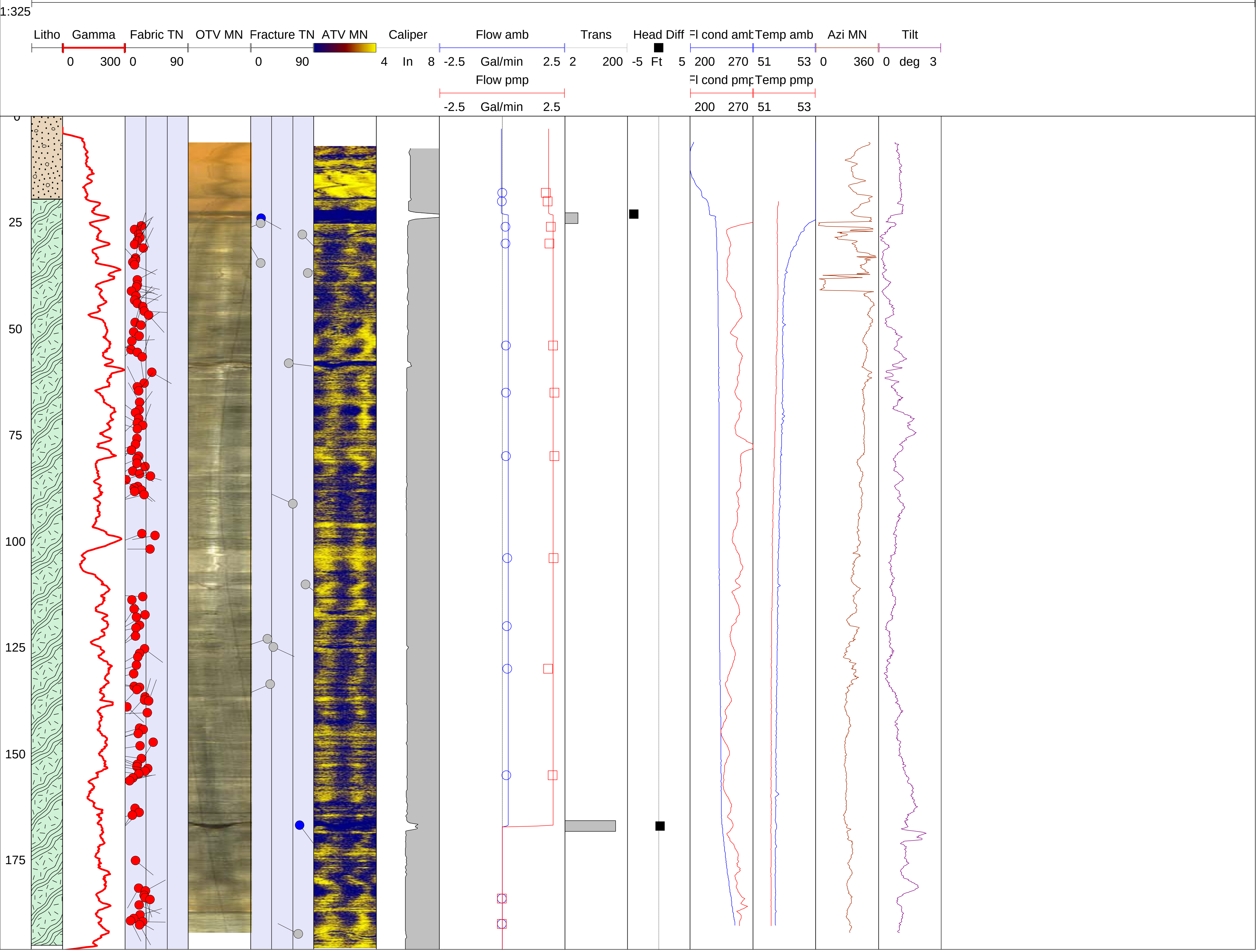
Hydrologic conditions Ambient, pump 1.8 gal/min, start pump at 14:42 stop pump at 16:40. Drawdown= 1.63ft	**Type of log** ZZ

Tool manufacturer and model, tool serial number, log date and time, logging direction and speed, depth error after logging, log parameter(s) and date(s) of calibration check

Tool run 1	Century 9065-715, 09:24, log up 20ft/min, depth error= -0.1ft, caliper in hole cal check.
Tool run 2	Century 9620-1046, 09:55, log up 20 ft/min, depth error= 0.17, magnetic suscept/gamma/deviation-surface tilt test
Tool run 3	Century 9801-1106, 10:27, log up 9 ft/min, depth error= 0.03, acoustic image and deviation
Tool run 4	Mount Sopris - 073612, 11:17, log up 6 ft/min,depth error= 0.0ft, optical image and deviation-tilt test at surface
Tool run 5	Century 9721-1162, log down 15ft/min, 12:01, ambient fluid temp and cond in-hole cal check
Tool run 6	Century 9721-1162, stationary , 12:26, ambient flow in-hole cal check
Tool run 7	Century 9721-1162, log down 15ft/min, 15:00, pump fluid temp and cond- in-hole cal check
Tool run 8	Century 9721-1162, stationary , 15:19, pump flow in-hole cal check
Tool run 9	

Remarks Casing stickup = 1.6ft.
LMP altitude from topo.

Du 3249/SHN-589



BOREHOLE GEOPHYSICAL LOG

English/Metric units E

SiteID (C1) 413127073472601	**Station name (C12)** Du 3267	**Other ID** SHN-591	**Log date** 1/21/2010
County Dutchess	**State** New York	**Project** CCW00	**Recorded by** JAA
Observed by GWS			
Location description Well in front yard	**Owner**		
Latitude 41 31 26.9	**Longitude** 073 47 25.8	**Lat/Long datum** NAD83	**Log measurement point (LMP)** LS
Height LMP 0.0	**Altitude LMP** 355*	**Altitude datum** NGVD29	**Description of LMP** Land surface
Borehole depth 155	**Borehole diameter** 6	**Casing bottom** 33	**Casing diameter** 6
Casing type Steel			
Source of data USGS	**Logging unit** Troy	**Log orientiation** MN	**Magnetic declination** -13.5
Software non-ASCII logs	**Fluid type** Water	**Fluid depth below LMP** 1.30	**at time** 13:02
Hydrologic conditions Flowing into pitless at 2gal/min, pump 3.0gal/min, start pump at 12:17 stop pump at 13:00, drawdown= 2.55ft	**Type of log** ZZ		

Tool manufacturer and model, tool serial number, log date and time, logging direction and speed, depth error after logging, log parameter(s) and date(s) of calibration check

Tool run 1 Century 9065, 574, 08:46, log up 20ft/min, depth error= 0.29ft, caliper cal check 10/21/2009.

Tool run 2 Century 9042-858, 08:55, log down 20 ft/min, depth error= 0.12 ft, gamma and ambient fluid temp and cond- fluid temp and cond - temp and cond cal check 10/30/2009.

Tool run 3 Century 9510, 746, 09:21, log up 20ft/min, depth error= .09ft, gamma and EM induction- cond cal 1/18/2010.

Tool run 4 Mount Sopris -OBI-MK4, 073612, 10:00, log up 6 ft/min, depth error= -0.04ft, optical image and deviation- in hole cal check

Tool run 5 Mount Sopris- ABI-40, 3078-020906, 10:39, log up 5ft/min, depth error = 0.05ft, acoustic image and deviation-in hole cal check.

Tool run 6 Century 9721-1162, stationary , 11:30, ambient electromagnetic flowmeter in-hole cal check

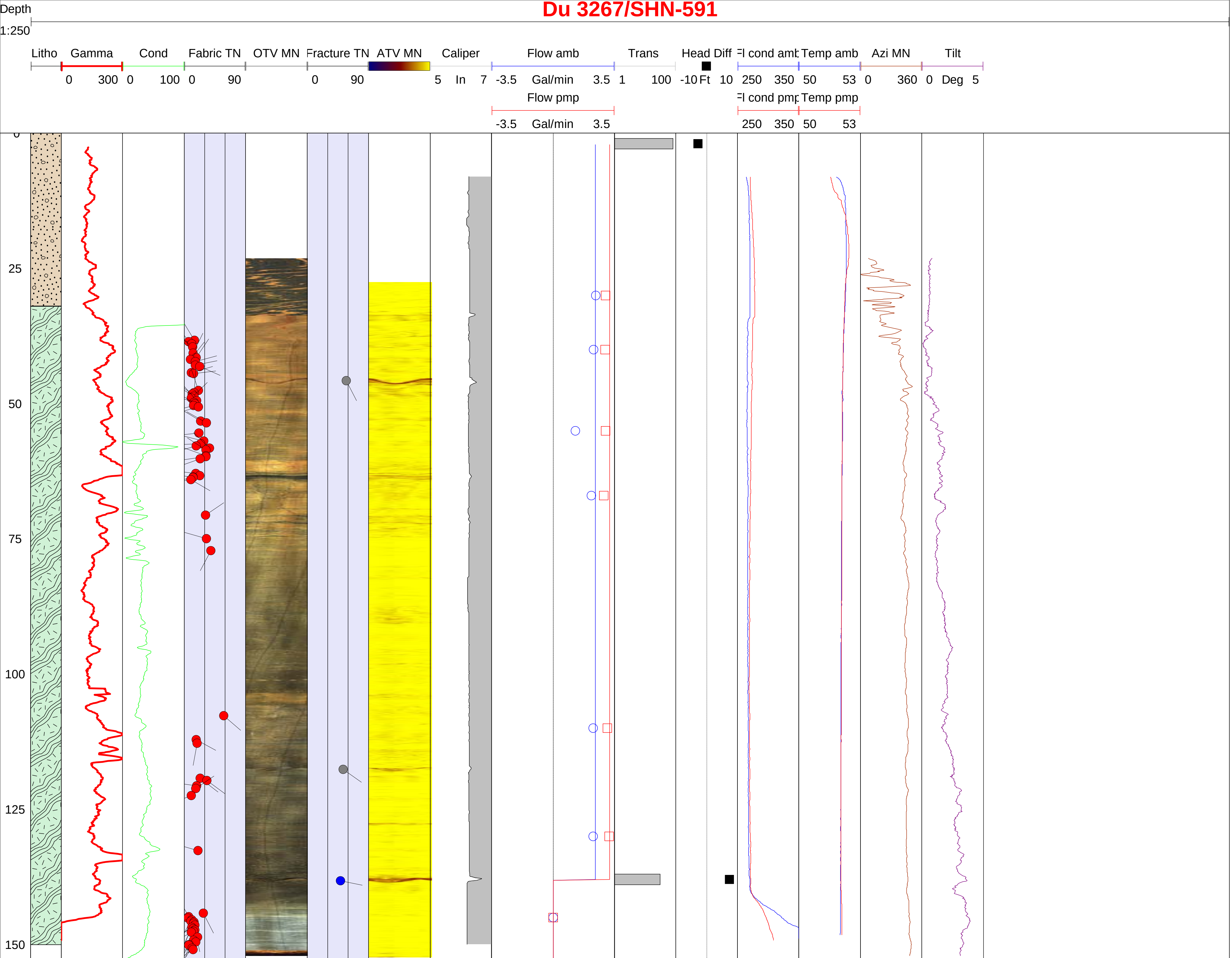
Tool run 7 Century 9721-1162, stationary , 12:30, depth error= 0.12, pumped electromagnetic flowmeter -in-hole cal check

Tool run 8 Century 9042-858, 13:07, log down 20 ft/min, depth error= 0.12 ft, gamma and pumping fluid temp and cond

Tool run 9

Remarks Casing stickup = 1.1ft above land surface.
*Altitude from topo.

Du 3267/SHN-591



BOREHOLE GEOPHYSICAL LOG

English/Metric units E

SiteID (C1) 413124073472501 **Station name (C12)** Du 3260 **Other ID** SHN-603 **Log date** 10/21/2009

County Dutchess **State** New York **Project** CCW00 **Recorded by** JAA **Observed by** RJR

Location description Well at end of driveway behind fence **Owner**

Latitude 41 31 24.0 **Longitude** 073 47 24.6 **Lat/Long datum** NAD83 **Log measurement point (LMP)** LS

Height LMP 0.0 **Altitude LMP** 348 **Altitude datum** NGVD29 **Description of LMP** Land surface

Borehole depth 248 **Borehole diameter** 6 **Casing bottom** 24.5 **Casing diameter** 6 **Casing type** steel

Source of data USGS **Logging unit** Troy **Log orientiation** MN **Magnetic declination** -13.5

Software non-ASCII logs **Fluid type** water **Fluid depth below LMP** 2.80 **at time** 13:02

Hydrologic conditions ambient, pump 2.4gal/min, start pump at 14:07 stop pump at 15:04, drawdown= 4.24ft. well flowing **Type of log** ZZ

Tool manufacturer and model, tool serial number, log date and time, logging direction and speed, depth error after logging, log parameter(s) and date(s) of calibration check

Tool run 1 Century 9065, 574, 11:06, log up 20ft/min, depth error= 0.01ft, caliper cal check 10/21/2009.

Tool run 2 Century 9042-858, 08:39, log down 20 ft/min, depth error= 0.05 ft, gamma and ambient fluid temp and cond- fluid temp and cond in hole cal check.

Tool run 3 Century 9800-1106, 09:17, log up 9ft/min, depth error= 0.25ft, acoustic image and deviation- in hole cal check.

Tool run 4 Mount Sopris -OBI-MK4, 073612, 11:00, log up 6ft/min, depth error= 0.06ft, optical image and deviation- in hole cal check

Tool run 5 Century 9721, 1162, 11:53, log down stationary measurments, ambient EMFM flowmeter- in hole cal check

Tool run 6 Century 9721, 1162, 14:27, log up stationary measurments, depth error= 0.41ft, pumping EMFM flowmeter- in hole cal check

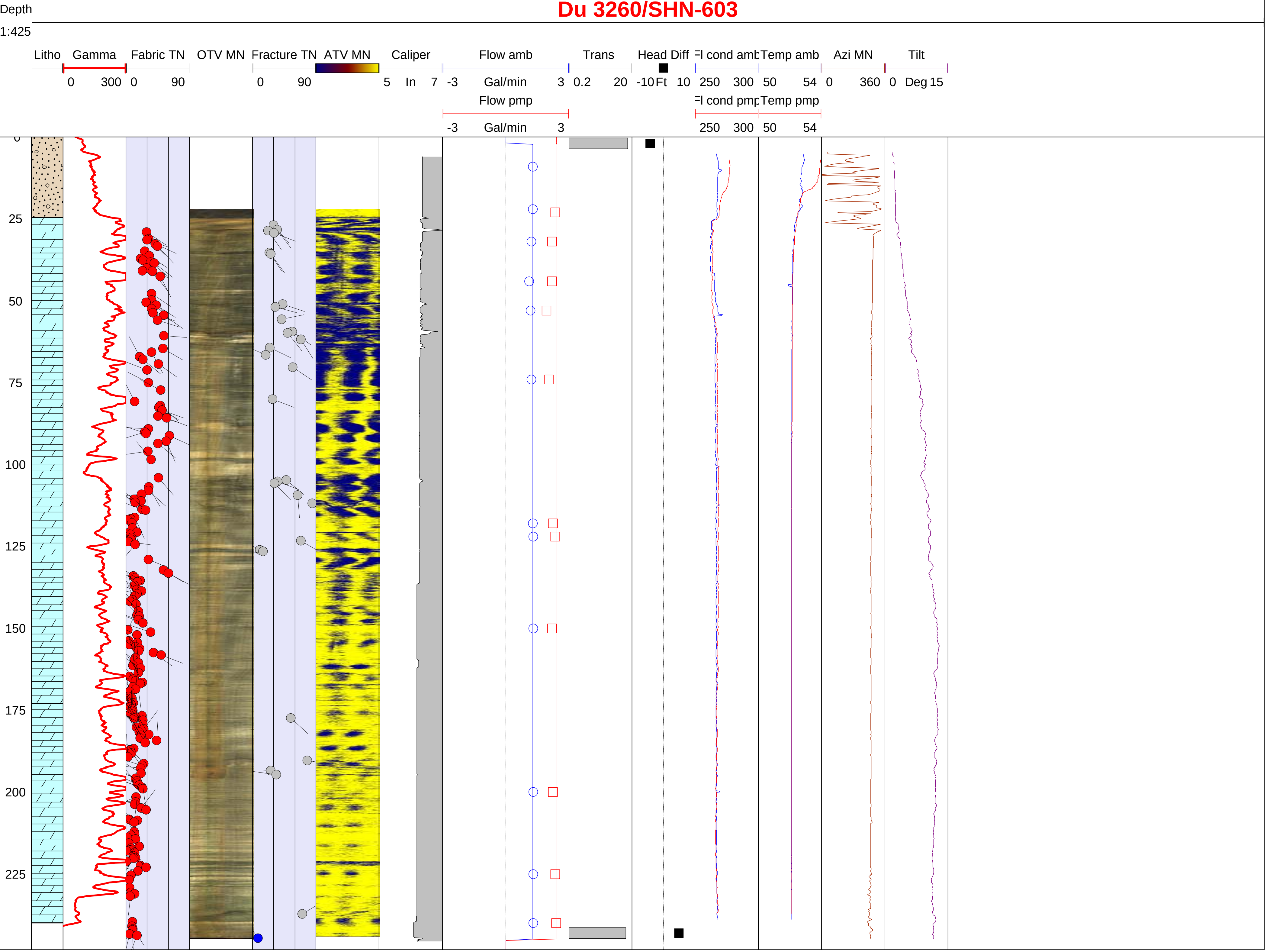
Tool run 7 Century 9042-858, 15:12, log down 20ft/min, depth error= 0.05 ft, gamma and pumping fluid temp and cond

Tool run 8

Tool run 9

Remarks Casing stickup = 1.2ft above land surface.
Altitude from topo.

Du 3260/SHN-603



BOREHOLE GEOPHYSICAL LOG

English/Metric units E

SiteID (C1) 413130073473501	**Station name (C12)** Du 3253	**Other ID** STN-051	**Log date** 10/30/2009
County Dutchess	**State** New York	**Project** CCW00	**Recorded by** JAA
Observed by			
Location description Well in back yard close to ledge	**Owner**		
Latitude 41 31 29.6	**Longitude** 073 47 34.7	**Lat/Long datum** NAD83	**Log measurement point (LMP)** LS
Height LMP 0.0	**Altitude LMP** 535	**Altitude datum** NGVD29	**Description of LMP** Land surface
Borehole depth 212.5	**Borehole diameter** 6	**Casing bottom** 19.5	**Casing diameter** 6
Casing type steel			
Source of data USGS	**Logging unit** Troy	**Log orientiation** MN	**Magnetic declination** -13.5
Software non-ASCII logs	**Fluid type** water	**Fluid depth below LMP** 98.81	**at time** 12:36
Hydrologic conditions ambient, pump 1.0gal/min, start pump at 12:37 stop pump at 14:05, drawdown= 1.51ft	**Type of log** ZZ		

Tool manufacturer and model, tool serial number, log date and time, logging direction and speed, depth error after logging, log parameter(s) and date(s) of calibration check

Tool run 1 Century 9065, 574, 09:16, log up 25ft/min, depth error= 0.10ft,well bore diameter in inches - in hole cal check.

Tool run 2 Century 9042-858, 09:33, log down 25 ft/min, depth error= 0.09 ft, gamma and ambient fluid temp in deg F and cond in uS/cm- fluid temp and cond cal check in hole.

Tool run 3 Century 9800-1106, 10:00, log up 10 ft/min, depth error= 0.14ft, acoustic image and deviation- in hole cal check.

Tool run 4 Mount Sopris -OBI-MK4, 073612, 11:00, log up 10 ft/min, depth error= 0.28ft, optical image and deviation- in hole cal check

Tool run 5 Mount Sopris - HPFM, HFP2293, 11:47, log down stationary measurments, ambient heat pulse flowmeter

Tool run 6 Mount Sopris - HPFM, HFP2293, 12:50, log up stationary measurements, depth error= 0.25ft, pumping heat pulse flowmeter - in hole cal check.

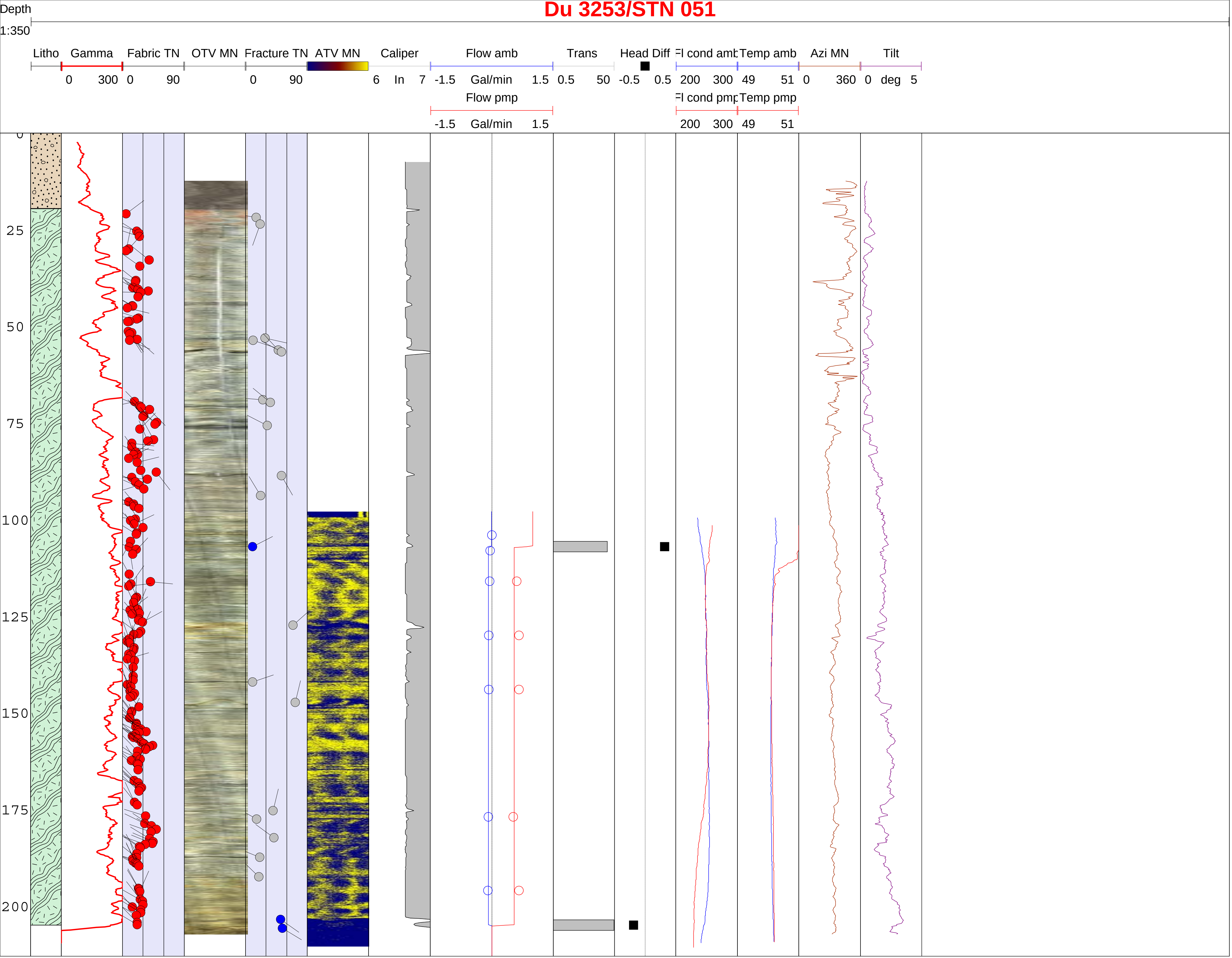
Tool run 7 Century 9042-858, 13:37, log down 25 ft/min, depth error= 0.10 ft, gamma and pumping fluid temp and cond

Tool run 8

Tool run 9

Remarks Casing stickup = 1.23ft above land surface.
Altitude from topo.

Du 3253/STN 051



BOREHOLE GEOPHYSICAL LOG

English/Metric units E

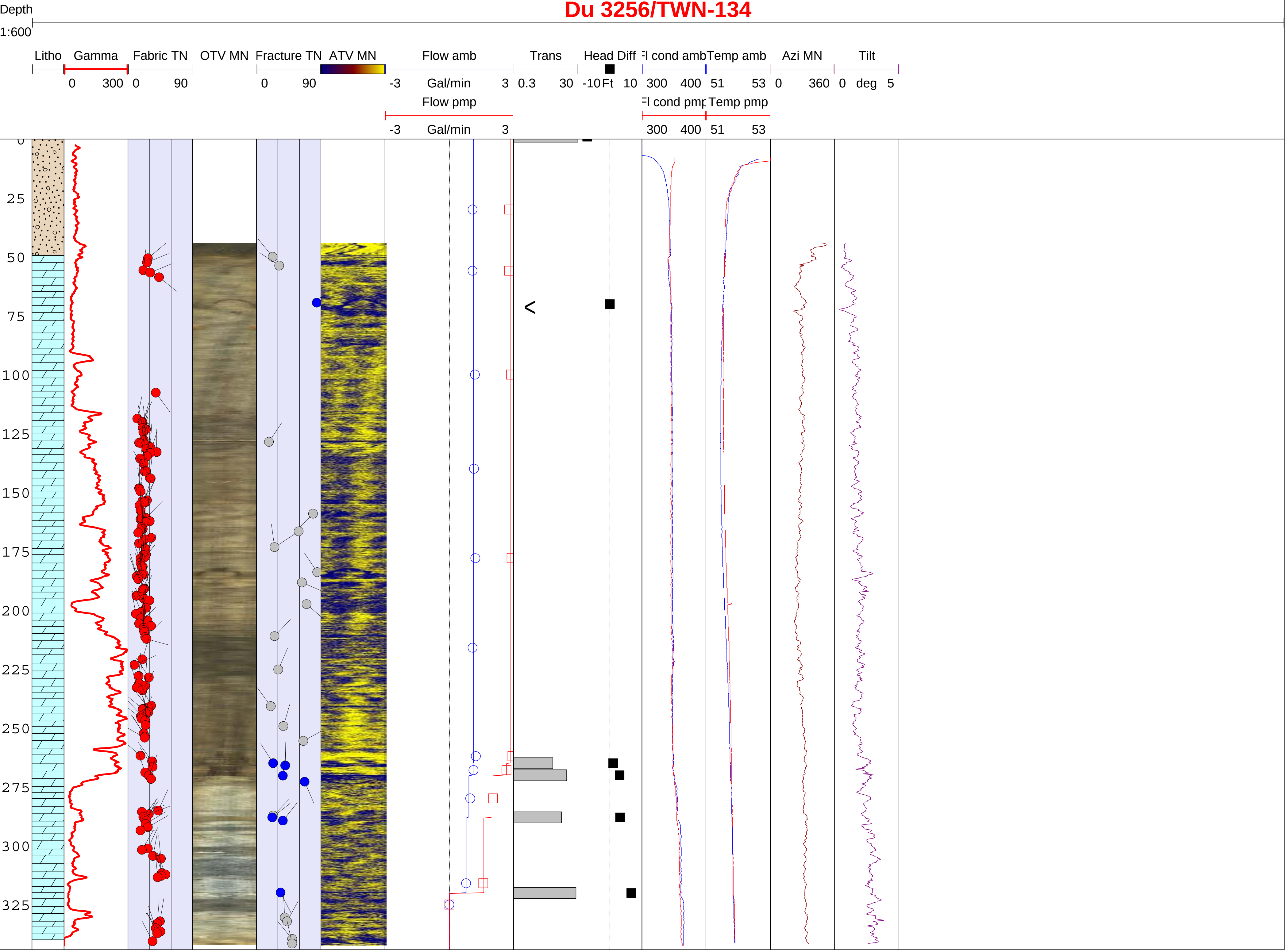
SiteID (C1) 413210073472101	**Station name (C12)** Du 3256	**Other ID** TWN-134		**Log date** 10/15/2009
County Dutchess	**State** New York	**Project** CCW00	**Recorded by** JAA	**Observed by** RJR
Location description Well in back yard			**Owner**	
Latitude 41 32 09.6	**Longitude** 073 47 20.9	**Lat/Long datum** NAD83	**Log measurement point (LMP)** LS	
Height LMP 0.0	**Altitude LMP** 285	**Altitude datum** NGVD29	**Description of LMP** Land surface	
Borehole depth 344	**Borehole diameter** 6	**Casing bottom** 49.5	**Casing diameter** 6	**Casing type** steel
Source of data USGS	**Logging unit** Troy	**Log orientiation** MN	**Magnetic declination** -13.5	
Software non-ASCII logs	**Fluid type** water	**Fluid depth below LMP** flowing	**at time**	
Hydrologic conditions well flowing at 1 gal/min, pump 2.8gal/min, start pump at 15:40 stop pump at 16:44, drawdown= 7.02ft		**Type of log** ZZ		

Tool manufacturer and model, tool serial number, log date and time, logging direction and speed, depth error after logging, log parameter(s) and date(s) of calibration check

Tool run 1	Century 9042-858, 09:38, log down 20 ft/min, depth error= 0.05 ft, gamma and ambient fluid temp and cond- fluid temp and cond in hole cal check.
Tool run 2	Century 9800-1106, 10:38, log up 9 ft/min, depth error= 0.24ft, acoustic image and deviation- in hole cal check.
Tool run 3	Mount Sopris -OBI-MK4, 073612, 11:25, log up 6 ft/min, depth error= 0.19ft, optical image and deviation- in hole cal check
Tool run 4	Century 9042-858, 12:38, log down 20 ft/min, depth error= 0.1 ft, gamma and ambient fluid temp and cond
Tool run 5	Century 9721, 1162, 14:24, log down stationary measurments, ambient EMFM flowmeter- in hole cal check
Tool run 6	Century 9721, 1162, 16:07, log up stationary measurments, depth error= 0.0ft, pumping EMFM flowmeter- in hole cal check
Tool run 7	Century 9042-858, 16:58, log down 20 ft/min, depth error= 0.10 ft, gamma and pumping fluid temp and cond
Tool run 8	
Tool run 9	

Remarks Casing stickup = 1.1ft above land surface.
Altitude from topo.

Du 3256/TWN-134



A-2d: Lithologic Interpretations

Shenandoah Road Groundwater Contamination Superfund Site
Summary of Geophysical Logging of Residential Wells

Well	Depth Range (ft bgs)			Inferred Lithology Type*	Geophysical Log Basis	Est. Avg. Gamma (CPS)	Est. Gamma Range (CPS)	Notes
BRB-003	18.5	-	260.0	gneiss	high gamma	200	100-400	variable fabric orientation
	260.0	-	275.0	*fracture zone*	caliper	NA	NA	
BRB-005	20.0	-	275.0	gneiss	high gamma	200	50-300	variable fabric orientation
BRB-006	39.5	-	235.0	gneiss	high gamma	200	50-300	no caliper log, variable fabric orientation
BRB-007	15.0	-	230.0	gneiss	high gamma	200	100-300	variable fabric orientation throughout section
BRB-009	18.5	-	300.0	gneiss	high gamma	175	50-300	variable fabric orientation
BRB-011	31.5	-	215.0	gneiss	high gamma	200	50-300	possible fracture ~185-190'
BRB-014	31.0	-	199.0	gneiss**	high gamma	150	50-300	consistent fabric orientation; near SRMW-17R
CHN-472	8.0	-	38.0	quartzite	low gamma	75^	60-130^	lithology inferred from other wells; not logged below bottom of casing
EHC-002	27.0	-	277.0	gneiss	high gamma	200	100-300+	near normal fault boundary, variable fabric orientation
GRF-006	35.0	-	275.0	quartzite	low gamma	<50	<50	variable fabric orientation
	275.0	-	520.0	dolostone	int. gamma	100	50-150	consistent fabric orientation
	520.0	-	640.0	quartzite	low gamma	50	<50-100	variable fabric orientation, possible overturned section
GRF-007 (Deep)	35.0	-	245.0	quartzite	low gamma	<50	<50	variable fabric orientation, possible overturned section
	245.0	-	385.0	dolostone	int. gamma	125	75-200	low gamma (<50 CPS) zone at ~312-318 feet
GRF-007	22.5	-	40.0	shaly dolost.	high gamma	200	150-300	consistent fabric, near SRMW-6R & normal fault boundary
	40.0	-	91.0	quartzite	low gamma	<50	<50	
JCK-117	60.0	-	172.0	dolostone	low gamma	<50	<50	
	172.0	-	275.0	shaly dolost.	high gamma	150	50-225	shaly interbeds within primary dolostone unit
	275.0	-	360.0	dolostone	low gamma	<50	<50	
	360.0	-	490.0	shaly dolost.	high gamma	150	75-225	gamma increasing throughout interval, consistent fabric below 425'
	490.0	-	500.0	dolostone	low gamma	<50	<50	highly variable gamma; suspect alternating dolostone and shaly dolostone; gneiss not likely due to consistent fabric orientation
	500.0	-	520.0	shaly dolost.	high gamma	150	150-250	
OTN-007	60.0	-	323.0	dolostone	int. gamma	75	50-300	consistent fabric orientation
SEY-004	36.0	-	159.0	gneiss	high gamma	150	100-200	variable fabric orientation
SEY-005	51.5	-	145.0	shaly dolost.	high gamma	200	150-300	strong consistent fabric w/ abrupt directional change at 145', between SRMW-17R (gneiss) and SRMW-19R (shaly dolostone), fault suggested
	145.0	-	322.0	gneiss	high gamma	150	50-300	
SEY-006	31.0	-	220.0	gneiss	high gamma	150	50-300	variable fabric orientation
SEY-007	42.0	-	115.0	shaly dolost.	high gamma	200	100-300	gamma increasing throughout interval to 102', consistent fabric orientation
SHN-466	105.0	-	330.0	quartzite	low gamma	<50	<50-150	somewhat consistent fabric orientation
	330.0	-	483.0	shaly dolost.	high gamma	150	50-300	consistent fabric orientation
SHN-472	5.0	-	85.0	quartzite	low gamma	75^	25-125^	lithology inferred from other wells; not logged below bottom of casing
SHN-478	62.0	-	105.0	quartzite	low gamma	100	50-250	possible transitional zone into dolostone
SHN-499	24.0	-	140.0	gneiss	high gamma	150	50-350	variable fabric orientation
SHN-589	19.5	-	190.0	gneiss	high gamma	175	75-300	variable fabric orientation
SHN-591	33.0	-	154.0	gneiss	high gamma	150	100-300+	variable fabric, low-angle fractures at 45', 120', 140'
SHN-603	24.5	-	240.0	gneiss	high gamma	250	100-500	strong consistent fabric, fabric directional change at ~100'
STN-051	19.5	-	205.0	gneiss	high gamma	250	100-400	variable fabric
TWN-134	49.5	-	115.0	dolostone	low gamma	50	25-125	
	115.0	-	200.0	shaly dolost.	high gamma	150	75-225	strong consistent fabric
	200.0	-	270.0	shaly dolost.	high gamma	250	150-300	variable fabric
	270.0	-	340.0	quartzite	low gamma	50	25-125	

Notes:

* The inferred lithologic types are preliminary interpretations based on limited geophysical data and a review of conventional borehole logs from nearby monitoring wells. The interpretations are intended for discussion purposes only and are subject to change.

** Log for nearby well SRMW-17R suggests high quartz fraction.

^ Possible gamma response through steel cased interval.

The diameter of all boreholes is 6 inches; therefore, the gamma tool response does not require correction for borehole diameter from well to well.

Attachment B: Relevant Correspondence

New York State Department of Environmental Conservation
Division of Water
Bureau of Water Permits, 4th Floor
625 Broadway, Albany, New York 12233-3505
Phone: (518) 402-8111 • **FAX:** (518) 402-9029
Website: www.dec.state.ny.us

Joe Martens
Commissioner

MEMORANDUM

TO: Dave Crosby, Remedial Bureau C and
Kiera Becker
FROM: Sudhir Mahatma, BWP SM.
SUBJECT: **Shenandoah Road Site # 3-14-104**
DRAINAGE BASIN: 13-04
DATE: April 02, 2012

In response to your request dated March 5,2012 and April 2,2012, attached please find effluent limitations and monitoring requirements for the above noted remediation discharge.

The DOW does not have any regulatory authority over a discharge from a State, PRP, or Federal Superfund Site. DER will be responsible for ensuring compliance with the attached effluent limitations and monitoring requirements, and approval of all engineering submissions. Footnote 1 identifies the appropriate DER Section Chief as the place to send all effluent results, engineering submissions, and modification requests. The Regional Water Engineer should be kept appraised of the status of this discharge and, in accordance with the attached criteria, receive a copy of the effluent results for informational purposes.

If you have any questions, please call me at 2-8126 .

Attachment (Effluent Limitations and Monitoring Requirements)

cc: Regional Water Engineer, R-3(w/attach)
Shayne Mitchell, Section Chief, DOW (w/attach)
Ron Entringer,

EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

During the period beginning April 2, 2012 and lasting until March 31, 2017, the discharges from the treatment facility to trib. of Wickopee Creek , water index number H-95-13-3-1 , Class C, shall be limited and monitored by the operator as specified below:

Outfall Number and Parameter	Discharge Limitations		Units	Minimum Monitoring Requirements	
	Monthly Avg.	Daily Max		Measurement Frequency	Sample Type
Outfall 001 - Treated Groundwater Remediation Discharge:					
Flow	Monitor	43,200	GPD	Continuous	Meter
pH (range)	6.5 to 8.5		SU	Monthly	Grab
TDS mg/l	Monitor	Monitor	mg/l	Monthly	Grab
Acetone mg/l	Monitor	Monitor	mg/l	Monthly	Grab
Aluminum, Total	Monitor	0.03	lb/d	Monthly	24 hr. comp.
Antimony , Total	Monitor	Monitor	lb/d	Monthly	24 hr. comp
Arsenic, Total	Monitor	0.06	lb/d	Monthly	24 hr. comp
Barium, Total	Monitor	Monitor	lb/d	Monthly	24 hr. comp
Cadmium, Total	Monitor	0.0003	lb/d	Monthly	24 hr. comp
Chromium, Total	Monitor	0.02	lb/d	Monthly	24 hr. comp
Cobalt, Total	Monitor	0.02	lb/d	Monthly	24 hr. comp
Copper, Total	Monitor	0.001	lb/d	Monthly	24 hr. comp
Iron, Total	Monitor	0.300	lb/d	Monthly	24 hr. comp
Lead, Total	Monitor	0.0007	lb/d	Monthly	24 hr. comp
Nickel, Total	Monitor	0.006	lb/d	Monthly	24 hr. comp
Thallium, Total	Monitor	0.002	lb/d	Monthly	24 hr. comp
Zinc, Total	Monitor	0.008	lb/d	Monthly	24 hr. comp
Tetrachloroethene	Monitor	1.0	ug/l	Monthly	Grab
Toluene	Monitor	5.0	ug/l	Monthly	Grab

Additional Conditions:

(1) Discharge is not authorized until such time as an engineering submission showing the method of treatment is approved by the Department. The discharge rate may not exceed the effective or design treatment system capacity. All monitoring data, engineering submissions and modification requests must be submitted to:

Dave Crosby, Remedial Bureau C
NYSDEC, 625 Broadway,
Albany, New York 12233- 7014
518-402-9662

With a copy sent to:

Regional Water Engineer, Region – 3
21 South Putt Corners Rd.
New Paltz, NY 12561
914-428-2505

(2) Only site generated wastewater is authorized for treatment and discharge.

(3) Authorization to discharge is valid only for the period noted above but may be renewed if appropriate. A request for renewal must be received 6 months prior to the expiration date to allow for a review of monitoring data and reassessment of monitoring requirements.

(4) Both concentration (mg/l or µg/l) and mass loadings (lbs/day) must be reported to the Department for all parameters except flow and pH.

(5) Any use of corrosion/scale inhibitors, biocidal-type compounds, or other water treatment chemicals used in the treatment process must be approved by the department prior to use.

(6) This discharge and administration of this discharge must comply with the substantive requirements of 6NYCRR Part 750.

Attachment C: Monitoring Schedules

Comprehensive Monitoring Plan
Attachment C: Monitoring Schedules
Shenandoah Road Groundwater Contamination Superfund Site
Federal Superfund Identification Number: NYSFN0204269
New York State ID: 3-14-104

General Notes:
Where blank, no samples are collected from that location.
Q: Quarterly, S: Semiannual, A: Annual, M: Monthly

Notes on Frequency of Sampling:
Monitoring continues from the 19th to the 30th year for ice-contact aquifer wells and seeps and surface water
*Where noted, includes MNA indicator parameters Nitrate and Dissolved Oxygen

Well Location	***FLUTe Port or Monitoring Interval***	***Monitoring Frequencies and Schedule***			
		Year 1 t0 5	Year 6 to 15	Year 16 to18	Year 19 to 30
Table C-1: Groundwater Monitoring					
SRMW-1RC		S*	A*	A*	
SRMW-2RA		S*	A*	A*	
SRMW-11R	Port 4	S*	A*	A*	
SRMW-12S		Q*	S*	Q*	S*
SRMW-12RA		Q*	S*	Q*	S*
SRMW-12RB		S*	A*	A*	
SRMW-12RC		A	A	A	
SRMW-14S		Q*	S*	Q*	S*
SRMW-14R	Port 1	S*	A*	A*	
	Port 2	A	A	A	
SRMW-14RA		S*	A*	A*	
SRMW-14RB		Q*	S*	Q*	S*
SRMW-15R	Port 2	A*	A*	A*	
	Port 3	S*	A*	A*	
	Port 4	Q*	S*	Q*	
SRMW-16R	Port 1	A	A	A	
	Port 2	A	A	A	
	Port 3	Q*	S*	Q*	
SRMW-17R	Port 2	A	A	A	
	Port 3	S*	A*	A*	
	Port 4	Q	S	Q	
	Port 5	S*	A*	A*	
	Port 6	A	A	A	
	Port 7	Q*	S*	Q*	
SRMW-18RD		Q*	S*	Q*	
SRMW-18RF	Port 1	S*	A*	A*	
BRB003		Q*	S*	Q*	
BRB005	Shallow	S*	A*	A*	
	Deep	Q*	S*	Q*	
BRB006	Shallow	S*	A*	A*	
	Deep	Q*	S*	Q*	
BRB007	Shallow	S	A	A	
	Deep	Q	S	Q	
BRB009	Shallow	S	A	A	
	Deep	Q*	S*	Q*	
BRB011	Shallow	S	A	A	
	Deep	Q*	S*	Q*	
EHC002	Deep	S*	A*	A*	
EHC009		A	A	A	

General Notes:
Where blank, no samples are collected from that location.
Q: Quarterly, S: Semiannual, A: Annual, M: Monthly

Notes on Frequency of Sampling:
Monitoring continues from the 19th to the 30th year for ice-contact aquifer wells and seeps and surface water
* Where noted, includes MNA indicator parameters Nitrate and Dissolved Oxygen

EHC017		A	A	A	
GRF006		A	A	A	
GRF007		A	A	A	
JCK117		A	A	A	
JCK140		Q*	S*	Q*	
OTN007		Q*	S*	Q*	
SEY005	Shallow	Q*	S*	Q*	
	Deep	Q*	S*	Q*	
SEY006		Q*	S*	Q*	
SEY007	Shallow	A	A	A	
	Deep	A*	A*	A*	
SHN472		Q*	S*	Q*	S*
SHN478	Shallow	Q	S	Q	S
	Deep	A	A	A	
SHN499	Shallow	Q*	S*	Q*	
	Deep	S*	A*	A*	
SHN589		Q*	S*	Q*	
SHN603		Q*	S*	Q*	
STN051	Shallow	S*	A*	A*	
	Deep	Q*	S*	Q*	
TWN134	300 ft	Q	S	Q	

Source Extraction Wells *(Collected Concurrently with SPDES Samples)*

Well Location		***Monitoring Frequencies and Schedule***			
		Year 1 t0 5	Year 6 to 15	Year 16 to18	Year 19 to 30
SRMW-18RA		M	M	Q	S
SRMW-18RB		M	M	Q	S
SRMW-18RC		M	M	Q	S
SRMW-18RE		M	M	Q	S

Comprehensive Monitoring Plan
Attachment C: Monitoring Schedules
Shenandoah Road Groundwater Contamination Superfund Site
Federal Superfund Identification Number: NYSFN0204269
New York State ID: 3-14-104

General Notes:
Where blank, no samples are collected from that location.
Q: Quarterly, S: Semiannual, A: Annual, M: Monthly

Notes on Frequency of Sampling:
Monitoring continues from the 19th to the 30th year for ice-contact aquifer wells and seeps and surface water
* Where noted, includes MNA indicator parameters Nitrate and Dissolved Oxygen

Table C-2: Shallow Facility Groundwater (Pit Water Samples)

Sampling Location		***Monitoring Frequencies and Schedule***			
		Year 1 t0 5	Year 6 to 15	Year 16 to18	Year 19 to 30
Large Pit Water Collection Pipe		Q	S	Q	S
Northern Water Collection Pipe		Q	S	Q	S
Central Water Collection Pipe		Q	S	Q	S
Southern Water Collection Pipe		Q	S	Q	S

Comprehensive Monitoring Plan
Attachment C: Monitoring Schedules
Shenandoah Road Groundwater Contamination Superfund Site
Federal Superfund Identification Number: NYSFN0204269
New York State ID: 3-14-104

General Notes:
Where blank, no samples are collected from that location.
Q: Quarterly, S: Semiannual, A: Annual, M: Monthly

Notes on Frequency of Sampling:
Monitoring continues from the 19th to the 30th year for ice-contact aquifer wells and seeps and surface water
* Where noted, includes MNA indicator parameters Nitrate and Dissolved Oxygen

Table C-3: Groundwater Seep

Groundwater Seep Location ID		***Monitoring Frequencies and Schedule***			
		Year 1 t0 5	Year 6 to 15	Year 16 to18	Year 19 to 30
SRSP-03		Q	S	Q	S

Comprehensive Monitoring Plan
Attachment C: Monitoring Schedules
Shenandoah Road Groundwater Contamination Superfund Site
Federal Superfund Identification Number: NYSFN0204269
New York State ID: 3-14-104

General Notes:
Where blank, no samples are collected from that location.
Q: Quarterly, S: Semiannual, A: Annual, M: Monthly

Notes on Frequency of Sampling:
Monitoring continues from the 19th to the 30th year for ice-contact aquifer wells and seeps and surface water
* Where noted, includes MNA indicator parameters Nitrate and Dissolved Oxygen

Table C-4: Surface Water

Surface Water Location ID		***Monitoring Frequencies and Schedule***			
		Year 1 t0 5	Year 6 to 15	Year 16 to18	Year 19 to 30
SRSW-12		Q	S	Q	S
SRSW-13		Q	S	Q	S
SRSW-14		Q	S	Q	S
SRSW-18		Q	S	Q	S

Comprehensive Monitoring Plan
Attachment C: Monitoring Schedules
Shenandoah Road Groundwater Contamination Superfund Site
Federal Superfund Identification Number: NYSFN0204269
New York State ID: 3-14-104

General Notes:
Where blank, no samples are collected from that location.
Q: Quarterly, S: Semiannual, A: Annual, M: Monthly

Notes on Frequency of Sampling:
Monitoring continues from the 19th to the 30th year for ice-contact aquifer wells and seeps and surface water
* Where noted, includes MNA indicator parameters Nitrate and Dissolved Oxygen

Table C-5: Sediments

Sediments Location ID	***Monitoring Intervals***	***Monitoring Frequencies and Schedule***			
		Year 1 t0 5	Year 6 to 15	Year 16 to18	Year 19 to 30
SRSD-12	0 to 6in; 6 to 12in	Q	S	Q	S
SRSD-13	0 to 6in; 6 to 12in	Q	S	Q	S
SRSD-14	0 to 6in; 6 to 12in	Q	S	Q	S
SRSD-18	0 to 6in; 6 to 12in	Q	S	Q	S

Attachment D: Quality Assurance Project Plan

SHENANDOAH ROAD GROUNDWATER CONTAMINATON SUPERFUND SITE
TOWN OF EAST FISHKILL, DUTCHESS COUNTY, NEW YORK

Quality Assurance Project Plan

Federal Superfund Identification Number: NYSFN0204269
NYSDEC Site Number: 3-14-104

Revisions to Final Approved Quality Assurance Project Plan:

Revision #	Submitted Date	Summary of Revision	Approval Date

DOCUMENT SUMMARY

This version of the QAPP is Revision 1 and is associated with data collection and analysis under the Remedial Design / Remedial Action Work Plan. The first version of the QAPP was Revision No. 0 and was issued as Appendix C to the Remedial Investigation / Feasibility Study Work Plan (dated September 19, 2005, see Worksheet #2, Item 5) and was previously approved by EPA. Appropriate modifications have been made to the QAPP consistent with the Uniform Federal Policy for Implementing Quality Systems (UFP-QS), EPA-505-F-03-001, March 2005 or newer, Uniform Federal Policy for Quality Assurance Project Plans (UFP-QAPP), Parts 1, 2, and 3, EPA-505-B-04-900A, B and C, March 2005 or newer, and other applicable guidance documents referenced in the aforementioned guidance documents.

All updates to the QAPP will be assigned a new incremental revision number; e.g., the next update will be Revision No. 2. The version number will be the designated "Revision No." shown in the upper right hand corner of each page of the QAPP. This revision number will be reflected on all pages of the QAPP, regardless of how many pages are actually affected by the revision.

A distribution record of the QAPP will be maintained in a spreadsheet and will be maintained by the GSC QAM. The distribution record will contain a list of personnel and organizations who have received copies of the QAPP, the date of receipt, and the version number that was received.

TABLE OF CONTENTS

TABLE OF ATTACHMENTS

- B-2: FLUTe Multi-level Monitoring System Documentation

Attachment C: Laboratory Plans and Procedures

- C-1: EnviroTest Laboratories, Inc.
- C-2: TestAmerica Burlington Laboratory

This version of the QAPP is Revision 1 and is associated with data collection and analysis under the Remedial Design / Remedial Action Work Plan. The first version of the QAPP was Revision No. 0 and was issued as Appendix C to the Remedial Investigation / Feasibility Study Work Plan (dated September 19, 2005, see Worksheet #2, Item 5) and was previously approved by EPA. Appropriate modifications have been made to the QAPP consistent with the Uniform Federal Policy for Implementing Quality Systems (UFP-QS), EPA-505-F-03-001, March 2005 or newer, Uniform Federal Policy for Quality Assurance Project Plans (UFP-QAPP), Parts 1, 2, and 3, EPA-505-B-04-900A, B and C, March 2005 or newer, and other applicable guidance documents referenced in the aforementioned guidance documents.

All updates to the QAPP will be assigned a new incremental revision number; e.g., the next update will be Revision No. 2. The version number will be the designated "Revision No." shown in the upper right hand corner of each page of the QAPP. This revision number will be reflected on all pages of the QAPP, regardless of how many pages are actually affected by the revision.

A distribution record of the QAPP will be maintained in a spreadsheet and will be maintained by the GSC QAM. The distribution record will contain a list of personnel and organizations who have received copies of the QAPP, the date of receipt, and the version number that was received.

QAPP Worksheet #1: Title and Approval Page

Site Name/Project Name: Shenandoah Road Groundwater Contamination Superfund Site

Site Location: Town of East Fishkill, New York

Title of Plan: Quality Assurance Project Plan (QAPP) for the Remedial Design / Remedial Action Work Plan implementation at the Shenandoah Road Groundwater Contamination Superfund Site in the Town of East Fishkill, Dutchess County, New York.

Implementing Organization: IBM Corporation

Effective Date: October 1, 2013

IBM Project Manager/Quality Assurance Manager	Name: Thomas D. Morris, P.E.
	Signature:
GSC Project Director	Name: Craig G. Robertson, P.G.
	Signature:
GSC Remedial Action Project Manager	Name: Dorothy A. Bergmann, P.G.
	Signature
GSC Remedial Design Project Manager	Matthew T. Luckman, P.E.
	Signature
GSC Quality Assurance Manager	Name: Charles A. Rine, P.G.
	Signature:
EPA Remedial Project Manager	Name: Damian Duda
	Signature:

QAPP Worksheet #2: QAPP Identifying Information

Site Name/Project Name: Shenandoah Road Groundwater Contamination Superfund Site
Site Location: Town of East Fishkill, New York
Site Number/Code: NYSFN0204269
Contractor Name: Groundwater Sciences Corporation

1. Identify regulatory program: NPL

2. Identify approval entity: EPA

3. The QAPP is (select one): Generic **X** Project Specific

4. List dates of scoping sessions that were held: 10/26/2006; 07/28/2008; 10/21/2008; 11/18/2008; 12/15/2008; 02/17/2009; 06/16/2009; 07/28/2009; 08/25/2009; 10/08/2009; 11/17/2009; 12/09/2009; 01/19/2010; 02/16/2010; 03/30/2010; 04/26/2010; 09/02/2010; 09/21/2010; 10/19/2010; 11/16/2010; 02/22/2011; 04/26/2011; 05/23/2011; 06/28/2011; 07/26/2011; 11/03/2011; 12/13/2011; 01/31/2012; 03/06/2012; 03/27/2012; 04/24/2012; 05/01/2012; 05/15/2012; 05/29/2012; 06/12/2012; 06/19/2012; 06/26/2012; 07/17/2012; 07/24/2012; 07/31/2012; 08/23/2012; 07/10/2013; 08/01/2013.

5. List dates and titles of QAPP documents written for previous site work, if applicable:

Title	Date
Quality Assurance Project Plan for the 7 East Hook Cross Road Facility Activities, Shenandoah Road Groundwater Contamination Superfund Site,CERCLA-02-2001-2002	06/06/2001
Quality Assurance Project Plan for the Point of Entry Treatment Systems and Residential Sampling, Shenandoah Road Groundwater Contamination Superfund Site, CERCLA-02-2001-2020	06/06/2001
Quality Assurance Project Plan for the Remedial Investigation / Feasibility Study, Shenandoah Road Groundwater Contamination Superfund Site, CERCLA-02-2002-2025	9/27/2005

6. List organizational partners (stakeholders) and connection with lead organization:
   EPA Region 2, New York State Department of Environmental Conservation, New York State Department of Health

7. List data users: EPA Region 2

8. If any required QAPP elements and required information are not applicable to the project, then circle the omitted QAPP elements and required information on the attached table. Provide an explanation for their exclusions below:

QAPP Worksheet #2
QAPP Identifying Information

Required QAPP Element(s) and Corresponding QAPP Section(s)	Required Information	Crosswalk to Related Documents
Project Management and Objectives		
2.1 Title and Approval Page	Title and Approval Page	1
2.2 Document Format and Table of Contents 2.2.1 Document Control Format 2.2.2 Document Control Numbering System 2.2.3 Table of Contents 2.2.4 QAPP Identifying Information	Table of Contents QAPP Identifying Information	2
2.3 Distribution List and Project Personnel Sign-Off Sheet 2.3.1 Distribution List 2.3.2 Project Personnel Sign-Off Sheet	Distribution List Project Personnel Sign-Off Sheet	3 4
2.4 Project Organization 2.4.1 Project Organizational Chart 2.4.2 Communication Pathways 2.4.3 Personnel Responsibilities and Qualifications 2.4.4 Special Training Requirements and Certification	Project Organizational Chart Communication Pathways Personnel Responsibilities and Qualifications Table Special Personnel Training Requirements Table	5 6 7 8
2.5 Project Planning/Problem Definition 2.5.1 Project Planning (Scoping) 2.5.2 Problem Definition, Site History, and Background	Project Planning Session Documentation (including Data Needs tables) Project Scoping Session Participants Sheet Problem Definition, Site History, and Background	 9 10
2.6 Project Quality Objectives and Measurement Performance Criteria 2.6.1 Development of Project Quality Objectives Using the Systematic Planning Process 2.6.2 Measurement Performance Criteria	Site-Specific PQOs Measurement Performance Criteria Table	11 12
2.7 Secondary Data Evaluation	Sources of Secondary Data and Information Secondary Data Criteria and Limitations Table	13
2.8 Project Overview and Schedule 2.8.1 Project Overview 2.8.2 Project Schedule	Summary of Project Tasks Reference Limits and Evaluation Table Project Schedule/Timeline Table	14 15 16

QAPP Worksheet #2
QAPP Identifying Information (continued)

Required QAPP Element(s) and Corresponding QAPP Section(s)	Required Information	Crosswalk to Related Documents
Measurement/Data Acquisition		
3.1 Sampling Tasks 3.1.1 Sampling Process Design and Rationale 3.1.2 Sampling Procedures and Requirements 3.1.2.1 Sampling Collection Procedures 3.1.2.2 Sample Containers, Volume, and Preservation 3.1.2.3 Equipment/Sample Containers Cleaning and Decontamination Procedures 3.1.2.3 Field Equipment Calibration, Maintenance, Testing, and Inspection Procedures 3.1.2.4 Supply Inspection and Acceptance Procedures 3.1.2.6 Field Documentation Procedures	Sampling Design and Rationale Sampling Locations and Methods/SOP Requirements Table Analytical Methods/SOP Requirements Table Field Quality Control Sample Summary Table Sampling SOPs Project Sampling SOP References Table Field Equipment Calibration, Maintenance, Testing, and Inspection Table	17 18 19 20 21 22
3.2 Analytical Tasks 3.2.1 Analytical SOPs 3.2.2 Analytical Instrument Calibration Procedures 3.2.3 Analytical Instrument and Equipment Maintenance, Testing, and Inspection Procedures 3.2.4 Analytical Supply Inspection and Acceptance Procedures	Analytical SOPs Analytical SOP References Table Analytical Instrument Calibration Table Analytical Instrument and Equipment Maintenance, Testing, and Inspection Table	 23 24 25
3.3 Sample Collection Documentation, Handling, Tracking, and Custody Procedures 3.3.1 Sample Collection Documentation 3.3.2 Sample Handling and Tracking System 3.3.3 Sample Custody	Sample Collection Documentation Handling, Tracking, and Custody SOPs Sample Container Identification Sample Handling Flow Diagram Example Chain-of-Custody Form and Seal	26, 27 27
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QAPP Worksheet #2
QAPP Identifying Information (continued)

Required QAPP Element(s) and Corresponding QAPP Section(s)	Required Information	Crosswalk to Related Documents
Assessment/Oversight		
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4.3 Final Project Report		
Data Review		
5.1 Overview		
5.2 Data Review Steps 5.2.1 Step I: Verification 5.2.2 Step II: Validation 5.2.2.1 Step IIa Validation Activities 5.2.2.2 Step IIb Validation Activities 5.2.3 Step III: Usability Assessment 5.2.3.1 Data Limitations and Actions from Usability Assessment 5.2.3.2 Activities	Verification (Step I) Process Table Validation (Steps IIa and IIb) Process Table Validation (Steps IIa and IIb) Summary Table Usability Assessment	34 35 36 NA
5.3 Streamlining Data Review 5.3.1 Data Review Steps To Be Streamlined 5.3.2 Criteria for Streamlining Data Review 5.3.3 Amounts and Types of Data Appropriate for Streamlining		NA

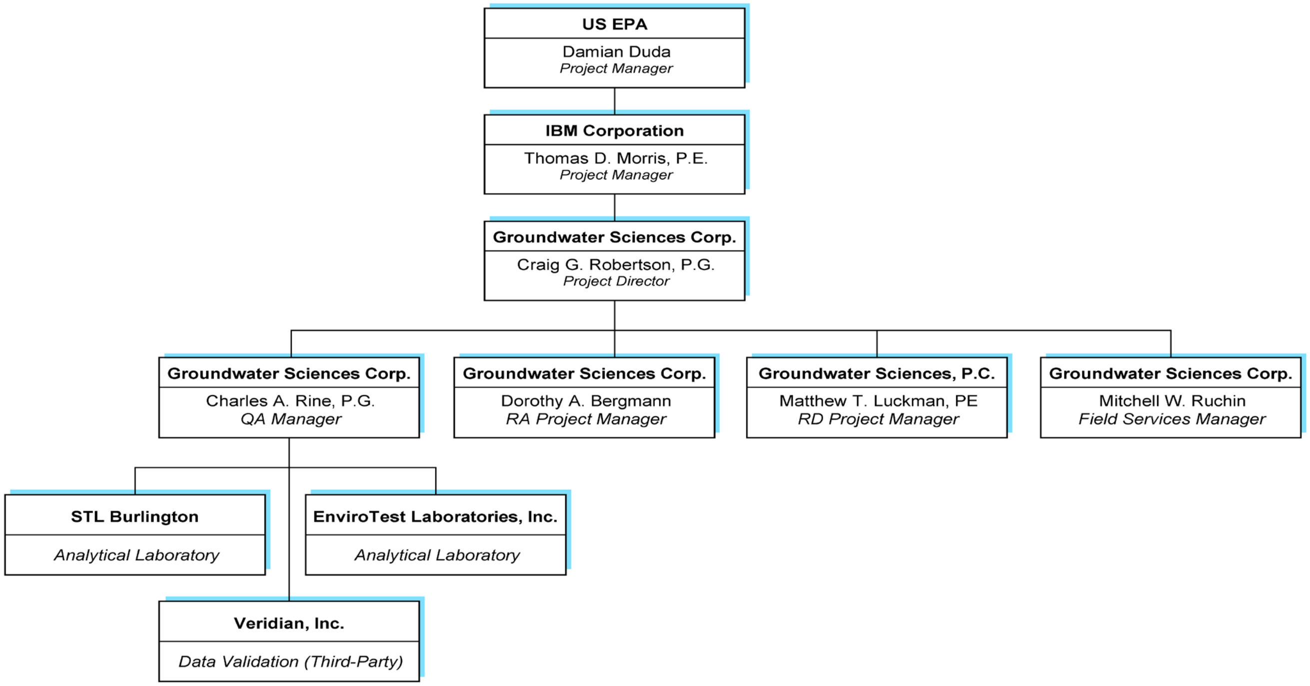
QAPP Worksheet #3: Distribution List

QAPP Recipients	Title	Organization	Contact Information
Damian Duda	EPA Remedial Project Manager (EPA RPM)	EPA	Emergency and Remedial Response Division, NYRB United States Environmental Protection Agency 290 Broadway, 20th Floor New York, NY 10007
Thomas D. Morris	IBM Project/Quality Assurance Manager (IBM PM/QAM)	IBM	IBM Corporation Rt 100, Bldg 2, MD 2393 Somers, New York 10589
Craig G. Robertson	GSC Project Director (GSC PD)	GSC	Groundwater Sciences Corporation 2601 Market Place Street, Suite 310 Harrisburg, PA 17110
Dorothy A. Bergmann	GSC Project Manager (GSC PM)	GSC	Groundwater Sciences Corporation 560 Route 52, Suite 202 Beacon, NY 12508
Matthew T. Luckman,	GS, PC Project Manager (GSC PM)	GS, PC	Groundwater Sciences Corporation 2601 Market Place Street, Suite 310 Harrisburg, PA 17110
Charles A. Rine	GSC QA Manager (GSC QAM) GSC Site Health and Safety Officer (GSC HASO)	GSC	Groundwater Sciences Corporation 2601 Market Place Street, Suite 310 Harrisburg, PA 17110
Mitchell W. Ruchin	GSC Field Services Manager (GSC FSM)	GSC	Groundwater Sciences Corporation 560 Route 52, Suite 202 Beacon, NY 12508
Charlotte Symms	Veridian Quality Assurance Manager (Veridian QAM)	Veridian	Veridian Environmental, Inc. 1111 Kennedy Place, Suite 2 Davis, CA 95616
Tracy A. Young	Veridian Data Validation Project Manager (Veridian PM)	Veridian	Veridian Environmental, Inc. 1111 Kennedy Place, Suite 2 Davis, CA 95616

QAPP Worksheet #4: Project Personnel Sign-Off Sheet

Project Personnel	Title	Signature	Date
Organization: United States Environmental Protection Agency			
Damian Duda	EPA Remedial Project Manager (EPA RPM)		
Organization: International Business Machines Corporation			
Thomas D. Morris	IBM Project/Quality Assurance Manager (IBM PM/QAM)		
Organization: Groundwater Sciences Corporation			
Craig G. Robertson	GSC Project Director (GSC PD)		
Dorothy A. Bergmann	GSC Project Manager (GSC PM)		
Charles A. Rine	GSC QA Manager (GSC QAM) GSC Site Health and Safety Officer (GSC HASO)		
Mitchell W. Ruchin	GSC Field Services Manager (GSC FSM)		
Organization: Groundwater Sciences, P.C.			
Matthew T. Luckman,	GS, PC Project Manager (GSC PM)		
Organization: Veridian Environmental, Inc.			
Charlotte Symms	Veridian Quality Assurance Manager (Veridian QAM)		
Tracy A. Young	Veridian Data Validation Project Manager (Veridian PM)		

QAPP Worksheet #5: Project Organizational Chart



QAPP Worksheet #6: Communication Pathways

Communication Drivers	Responsible Entity	Name	Phone Number	Procedure (Timing, Pathways, etc.)
Approval of initial QAPP and any amendments	EPA RPM	Damian Duda	(212) 637-4269	GSC internal peer review, followed by EPA approval, implementation of changes effective only with approved QAPP or QAPP Change Form.
Nonconformance and Corrective Action	GSC PM GSC FSM GS,PC PM GSC QAM Veridian PM	Dorothy Bergmann Mitchell Ruchin Matthew Luckman Charles Rine Tracy Young	(845) 896-0288 x14 (845)896-0288 x18 (717) 901-8186 (717) 901-8188 (530) 758-1903	Non-conformance and Corrective Action will be documented and reported on in Project Progress Reports and Data Validation Reports as applicable.
Posting of Deliverables to the Sharefile website	GSC PM GS,PC PM GSC QAM GSC Administrative Support	Dorothy Bergmann Matthew Luckman Charles Rine Administrative Support	(845) 896-0288 x14 (717) 901-8186 (717) 901-8188 (845) 896-0288	As per request or per work assignment, posting of deliverables to the Sharefile website constitutes delivery.
Work Assignment with Sampling Request Form(s)	GSC PM GS,PC PM GSC FSM	Dorothy Bergmann Matthew Luckman Mitchell Ruchin	(845) 896-0288 x14 (717) 901-8186 (845)896-0288 x18	Describes scope of work to GSC field personnel from the GSC PM, GS,PC PM or GSC FSM. Includes analytical requirements.
Health and Safety On-Site Meeting	Site Health and Safety Officer	Charles Rine	(717) 901-8188	Describe potential site hazards, required personal protective equipments, and access to local emergency services.

QAPP Worksheet #7: Personnel Responsibilities and Qualifications Table

Name	Title	Organizational Affiliation	Responsibilities	Education and Experience Qualifications
Damian Duda	Remedial Project Manager	EPA	Project Oversight	EPA job-specific qualifications/In EPA files
Diana Cutt		EPA	Technical Direction	EPA job-specific qualifications/In EPA files
Sergio Lopez	Quality Coordinator	EPA	QA Oversight	EPA job-specific qualifications/In EPA files
Thomas D. Morris, *P.E.*	Program Manager	IBM	Project Oversight	Qualifications to serve in this position have previously been submitted to EPA and approved
Craig G. Robertson, *P.G., C.G.W.P*	Program Director	GSC	Program Oversight	Qualifications to serve in this position have previously been submitted to EPA and approved
Dorothy A. Bergmann, *P.G.*	Program Manager	GSC	Project Management, Analytical Report and EDD Preparation	Qualifications to serve in this position have previously been submitted to EPA and approved
Charles A. Rine, *P.G.*	QA/QC Manager	GSC	QA & Validation Oversight/Deliverable Review	Qualifications to serve in this position have previously been submitted to EPA and approved
Mitchell W. Ruchin, *CWD, CPI*	Task Leader	GSC	Project Supervision/Sampling operations	Qualifications to serve in this position have previously been submitted to EPA and approved
Matthew T. Luckman, *P.E.*	Task Leader	GS,PC	Project Supervision/ Operations Maintenance SETS	Qualifications to serve in this position have previously been submitted to EPA and approved
Charlotte Symms	QA Manager	Veridian	Project Supervision / Data Validation	Qualifications to serve in this position have previously been submitted to EPA and approved
Tracy Young	Project Manager	Veridian	Data Validation and EDD Preparation	Qualifications to serve in this position have previously been submitted to EPA and approved

QAPP Worksheet #8: Special Personnel Training Requirements Table

Project Function	Specialized Training – Title or Description of Course	Personnel/Group Receiving Training	Personnel	Training Records & Certificates
Project Management	29CFR1910.120 OSHA 40 hour HAZWOPER RCRA Hazardous Waste Mgt Training 29CFR1910.120 OSHA 8-hour Supervisor 29CFR1910.120 OSHA 8-hour refresher Plus specialized training (Lock Out Tag Out / Control of Hazardous Energy; Confined Space Entry) * Certified Data Validator in NYS	GSC PM GSC QAM * GS,PC PM GSC FSM	Dorothy Bergmann * Charles Rine * Matthew Luckman Mitchell Ruchin	Health & Safety Files Quality Files
Sampling Operations	29CFR1910.120 OSHA 40 hour training 29CFR1910.120 OSHA 8-hour refresher Plus specialized training (Lock Out Tag Out / Control of Hazardous Energy; Confined Space Entry)	GSC field personnel	Charles E.Stoner Christopher Shannon Janis Ronis	Health & Safety Files Quality Files
Contract Laboratory Analysis	As per Laboratory QAPP	Lab Personnel	Lab Personnel	Health & Safety Files Quality Files
Sampling Quality Control / Data Processing Activities	As per Veridian SOP	Veridian PM Veridian QAM	Charlotte Symms Tracy Young	Health & Safety Files Quality Files

QAPP Worksheet #9: Project Scoping Session Participation Sheets

Project Name: Shenandoah Road EPA Remedial Project Manager: Damian Duda	Site Name: Shenandoah Road Groundwater Contamination Superfund Site Site Location: Town of East Fishkill, Dutchess County New York
Date of Session: 10/24/2006 Scoping Session Purpose: Selection of monitoring wells for USGS geophysical logging	

Name	Affiliation	Phone #	Project Role
Damian Duda	EPA	212-637-4269	EPA RPM
Grant Anderson	EPA	212-6374326	EPA Technical
Kiera Becker	NYSDEC	518-402-9662	NYSDEC PM
Karen Maiurano	NYSDEC	518-402-9662	NYSDEC PM
Becky Mitchell	NYSDOH	518-402-7880	NYSDOH PM
Tom Morris	IBM	914-766-2739	IBM PM
Craig Robertson	GSC	717-574-5062	GSC PD
Dorothy Bergmann	GSC	845-896-0288	GSC PM
Chuck Rine	GSC	717-901-8188	GSC PM

Date of Session: 07/28/2008
Scoping Session Purpose: Review of Remedial Investigation Round 2 groundwater monitoring well results.

Name	Affiliation	Phone #	Project Role
Damian Duda	EPA	212-637-4269	EPA RPM
Karen Maiurano	NYSDEC	518-402-9662	NYSDEC PM
Kristin Kulow	NYSDOH	607-432-3911	NYSDOH PM
Rich Reynolds	USGS	518-285-5677	USGS PM
Tom Morris	IBM	914-766-2739	IBM PM
Craig Robertson	GSC	717-574-5062	GSC PD
Dorothy Bergmann	GSC	845-896-0288	GSC PM
Mitchell Ruchin	GSC	845-896-0288	GSC FSM

Date of Session: 10/21/2008
Scoping Session Purpose: Review of Remedial Investigation Round 2 groundwater monitoring well results.

Name	Affiliation	Phone #	Project Role
Damian Duda	EPA	212-637-4269	EPA RPM
Grant Anderson *	EPA	212-6374326	EPA Technical
Karen Maiurano *	NYSDEC	518-402-9662	NYSDEC PM
Rich Reynolds *	USGS	518-285-5677	USGS PM
John Williams *	USGS	518-285-5670	USGS PD
Tom Morris	IBM	914-766-2739	IBM PM
Craig Robertson	GSC	717-574-5062	GSC PD
Dorothy Bergmann	GSC	845-896-0288	GSC PM

* Participated by teleconference.

Date of Session: 11/18/2008
Scoping Session Purpose: Selection of Long-term former domestic water supply wells.

Name	**Affiliation**	**Phone #**	**Project Role**
Damian Duda	EPA	212-637-4269	EPA RPM
Grant Anderson *	EPA	212-6374326	EPA Technical
Karen Maiurano *	NYSDEC	518-402-9662	NYSDEC PM
John Williams *	USGS	518-285-5670	USGS PD
Tom Morris	IBM	914-766-2739	IBM PM
Craig Robertson	GSC	717-574-5062	GSC PD
Dorothy Bergmann	GSC	845-896-0288	GSC PM

* Participated by teleconference.

Date of Session: 12/15/2008
Scoping Session Purpose: USGS Presentation of Geophysical Logging results of former domestic water supply wells.

Name	**Affiliation**	**Phone #**	**Project Role**
Damian Duda	EPA	212-637-4269	EPA RPM
Karen Maiurano *	NYSDEC	518-402-9662	NYSDEC PM
Kristin Kulow *	NYSDOH	607-432-3911	NYSDOH PM
John Williams	USGS	518-285-5670	USGS PD
Rich Reynolds *	USGS	518-285-5677	USGS PM
Tom Morris	IBM	914-766-2739	IBM PM
Craig Robertson*	GSC	717-574-5062	GSC PD
Dorothy Bergmann	GSC	845-896-0288	GSC PM

* Participated by teleconference.

Date of Session: 02/17/2009
Scoping Session Purpose: Review list of former domestic water supply wells to be converted for long-term monitoring.

Name	**Affiliation**	**Phone #**	**Project Role**
Damian Duda	EPA	212-637-4269	EPA RPM
Grant Anderson *	EPA	212-6374326	EPA Technical
Karen Maiurano *	NYSDEC	518-402-9662	NYSDEC PM
Kristin Kulow *	NYSDOH	607-432-3911	NYSDOH PM
Rich Reynolds *	USGS	518-285-5677	USGS PM
Tom Morris	IBM	914-766-2739	IBM PM
Craig Robertson	GSC	717-574-5062	GSC PD
Dorothy Bergmann	GSC	845-896-0288	GSC PM

* Participated by teleconference.

Date of Session: 06/16/2009
Scoping Session Purpose: Review monitoring results for former domestic water supply wells to be converted for long-term monitoring.

Name	**Affiliation**	**Phone #**	**Project Role**
Damian Duda	EPA	212-637-4269	EPA RPM
Grant Anderson *	EPA	212-6374326	EPA Technical
Karen Maiurano *	NYSDEC	518-402-9662	NYSDEC PM
Kristin Kulow *	NYSDOH	607-432-3911	NYSDOH PM
Rich Reynolds *	USGS	518-285-5677	USGS PM
Tom Morris	IBM	914-766-2739	IBM PM
Craig Robertson	GSC	717-574-5062	GSC PD
Dorothy Bergmann	GSC	845-896-0288	GSC PM

* Participated by teleconference.

Date of Session: 07/28/2009
Scoping Session Purpose: Review monitoring results for former domestic water supply wells to be converted for long-term monitoring.

Name	**Affiliation**	**Phone #**	**Project Role**
Damian Duda	EPA	212-637-4269	EPA RPM
Grant Anderson	EPA	212-6374326	EPA Technical
John Williams	USGS	518-285-5670	USGS PD
Rich Reynolds *	USGS	518-285-5677	USGS PM
Tom Morris	IBM	914-766-2739	IBM PM
Craig Robertson	GSC	717-574-5062	GSC PD
Dorothy Bergmann	GSC	845-896-0288	GSC PM

* Participated by teleconference.

Date of Session: 08/25/2009
Scoping Session Purpose: Review physical well data for former domestic water supply wells to be converted for long-term monitoring.

Name	**Affiliation**	**Phone #**	**Project Role**
Damian Duda	EPA	212-637-4269	EPA RPM
Grant Anderson *	EPA	212-6374326	EPA Technical
Karen Maiurano	NYSDEC	518-402-9662	NYSDEC PM
Kristin Kulow *	NYSDOH	607-432-3911	NYSDOH PM
Tom Morris	IBM	914-766-2739	IBM PM
Craig Robertson	GSC	717-574-5062	GSC PD
Dorothy Bergmann	GSC	845-896-0288	GSC PM

* Participated by teleconference.

Date of Session: 10/08/2009
Scoping Session Purpose: Review SAP for former domestic water supply wells to be converted for long-term monitoring.

Name	**Affiliation**	**Phone #**	**Project Role**
Damian Duda *	EPA	212-637-4269	EPA RPM
Grant Anderson *	EPA	212-6374326	EPA Technical
John Williams	USGS	518-285-5670	USGS PD
Rich Reynolds *	USGS	518-285-5677	USGS PM
Tom Morris *	IBM	914-766-2739	IBM PM
Craig Robertson *	GSC	717-574-5062	GSC PD
Dorothy Bergmann *	GSC	845-896-0288	GSC PM

* Participated by teleconference.

Date of Session: 11/17/2009
Scoping Session Purpose: Selection of MNA parameters, review USGS geophysical logging results. Review SAP for former domestic water supply wells to be converted for long-term monitoring.

Name	**Affiliation**	**Phone #**	**Project Role**
Damian Duda	EPA	212-637-4269	EPA RPM
Grant Anderson	EPA	212-6374326	EPA Technical
John Williams *	USGS	518-285-5670	USGS PD
Rich Reynolds *	USGS	518-285-5677	USGS PM
Alton Andersen *	USGS	518-285-5677	USGS Technical
Tom Morris	IBM	914-766-2739	IBM PM
Craig Robertson	GSC	717-574-5062	GSC PD
Dorothy Bergmann	GSC	845-896-0288	GSC PM

* Participated by teleconference.

Date of Session: 12/09/2009
Scoping Session Purpose: Selection of MNA parameters, review USGS geophysical logging results. Review SAP for former domestic water supply wells to be converted for long-term monitoring.

Name	**Affiliation**	**Phone #**	**Project Role**
Damian Duda	EPA	212-637-4269	EPA RPM
Karen Maiurano *	NYSDEC	518-402-9662	NYSDEC PM
Kristin Kulow *	NYSDOH	607-432-3911	NYSDOH PM
John Williams *	USGS	518-285-5670	USGS PD
Rich Reynolds *	USGS	518-285-5677	USGS PM
Tom Morris	IBM	914-766-2739	IBM PM
Craig Robertson	GSC	717-574-5062	GSC PD
Dorothy Bergmann	GSC	845-896-0288	GSC PM

* Participated by teleconference.

Date of Session: 01/19/2010
Scoping Session Purpose: Select Facility Aquifer Testing locations and discuss testing parameters

Name	**Affiliation**	**Phone #**	**Project Role**
Damian Duda	EPA	212-637-4269	EPA RPM
Grant Anderson *	EPA	212-6374326	EPA Technical
Karen Maiurano *	NYSDEC	518-402-9662	NYSDEC PM
John Williams *	USGS	518-285-5670	USGS PD
Rich Reynolds *	USGS	518-285-5677	USGS PM
Tom Morris	IBM	914-766-2739	IBM PM
Craig Robertson	GSC	717-574-5062	GSC PD
Dorothy Bergmann	GSC	845-896-0288	GSC PM

* Participated by teleconference.

Date of Session: 02/16/2010
Scoping Session Purpose: Select Facility Aquifer Testing locations and discuss testing parameters

Name	**Affiliation**	**Phone #**	**Project Role**
Damian Duda *	EPA	212-637-4269	EPA RPM
Grant Anderson *	EPA	212-6374326	EPA Technical
Karen Maiurano *	NYSDEC	518-402-9662	NYSDEC PM
Kristin Kulow *	NYSDOH	607-432-3911	NYSDOH PM
Rich Reynolds *	USGS	518-285-5677	USGS PM
Alton Andersen *	USGS	518-285-5677	USGS Technical
Tom Morris *	IBM	914-766-2739	IBM PM
Craig Robertson *	GSC	717-574-5062	GSC PD
Dorothy Bergmann *	GSC	845-896-0288	GSC PM
Mitchell Ruchin	GSC	845-896-0288	GSC FSM

* Participated by teleconference.

Date of Session: 03/30/2010
Scoping Session Purpose: Review former domestic water supply well discrete zone sampling results and SPDES Equivalency Requirements.

Name	**Affiliation**	**Phone #**	**Project Role**
Damian Duda	EPA	212-637-4269	EPA RPM
Grant Anderson *	EPA	212-6374326	EPA Technical
Karen Maiurano *	NYSDEC	518-402-9662	NYSDEC PM
Rich Reynolds *	USGS	518-285-5677	USGS PM
Tom Morris	IBM	914-766-2739	IBM PM
Craig Robertson	GSC	717-574-5062	GSC PD
Dorothy Bergmann	GSC	845-896-0288	GSC PM
Mitchell Ruchin	GSC	845-896-0288	GSC FSM

* Participated by teleconference.

Date of Session: 04/26/2010
Scoping Session Purpose: Discuss Aquifer Testing Work Plan (Long-Term Test).

Name	**Affiliation**	**Phone #**	**Project Role**
Damian Duda	EPA	212-637-4269	EPA RPM
Grant Anderson *	EPA	212-6374326	EPA Technical
Karen Maiurano	NYSDEC	518-402-9662	NYSDEC PM
Rich Reynolds *	USGS	518-285-5677	USGS PM
Tom Morris	IBM	914-766-2739	IBM PM
Craig Robertson	GSC	717-574-5062	GSC PD
Dorothy Bergmann	GSC	845-896-0288	GSC PM
Mitchell Ruchin	GSC	845-896-0288	GSC FSM

* Participated by teleconference.

Date of Session: 09/02/2010
Scoping Session Purpose: Select locations and propose construction details for the former domestic water supply wells to be converted to long-term monitoring locations

Name	**Affiliation**	**Phone #**	**Project Role**
Damian Duda *	EPA	212-637-4269	EPA RPM
Grant Anderson *	EPA	212-6374326	EPA Technical
Karen Maiurano *	NYSDEC	518-402-9662	NYSDEC PM
John Williams *	USGS	518-285-5670	USGS PD
Rich Reynolds *	USGS	518-285-5677	USGS PM
Tom Morris *	IBM	914-766-2739	IBM PM
Craig Robertson *	GSC	717-574-5062	GSC PD
Dorothy Bergmann *	GSC	845-896-0288	GSC PM
Mitchell Ruchin *	GSC	845-896-0288	GSC FSM

* Participated by teleconference.

Date of Session: 09/21/2010
Scoping Session Purpose: Review aquifer testing results.

Name	**Affiliation**	**Phone #**	**Project Role**
Damian Duda	EPA	212-637-4269	EPA RPM
Grant Anderson	EPA	212-6374326	EPA Technical
Karen Maiurano *	NYSDEC	518-402-9662	NYSDEC PM
Kiera Becker	NYSDEC	518-402-9662	NYSDEC PM
Rich Reynolds *	USGS	518-285-5677	USGS PM
Tom Morris	IBM	914-766-2739	IBM PM
Craig Robertson	GSC	717-574-5062	GSC PD
Dorothy Bergmann	GSC	845-896-0288	GSC PM
Mitchell Ruchin	GSC	845-896-0288	GSC FSM

* Participated by teleconference.

Date of Session: 10/19/2010
Scoping Session Purpose: Review aquifer testing results.

Name	**Affiliation**	**Phone #**	**Project Role**
Damian Duda *	EPA	212-637-4269	EPA RPM
Grant Anderson *	EPA	212-6374326	EPA Technical
Kiera Becker	NYSDEC	518-402-9662	NYSDEC PM
Rich Reynolds *	USGS	518-285-5677	USGS PM
Tom Morris	IBM	914-766-2739	IBM PM
Craig Robertson	GSC	717-574-5062	GSC PD
Dorothy Bergmann	GSC	845-896-0288	GSC PM
Mitchell Ruchin	GSC	845-896-0288	GSC FSM

* Participated by teleconference.

Date of Session: 11/16/2010
Scoping Session Purpose: Review aquifer testing results.

Name	**Affiliation**	**Phone #**	**Project Role**
Damian Duda *	EPA	212-637-4269	EPA RPM
Grant Anderson *	EPA	212-6374326	EPA Technical
Rich Reynolds *	USGS	518-285-5677	USGS PM
Tom Morris	IBM	914-766-2739	IBM PM
Craig Robertson *	GSC	717-574-5062	GSC PD
Dorothy Bergmann	GSC	845-896-0288	GSC PM
Mitchell Ruchin	GSC	845-896-0288	GSC FSM

* Participated by teleconference.

Date of Session: 02/22/2011
Scoping Session Purpose: Review constant rate aquifer testing results.

Name	**Affiliation**	**Phone #**	**Project Role**
Damian Duda	EPA	212-637-4269	EPA RPM
Grant Anderson *	EPA	212-6374326	EPA Technical
Kiera Becker	NYSDEC	518-402-9662	NYSDEC PM
Rich Reynolds *	USGS	518-285-5677	USGS PM
Tom Morris	IBM	914-766-2739	IBM PM
Craig Robertson *	GSC	717-574-5062	GSC PD
Dorothy Bergmann	GSC	845-896-0288	GSC PM
Mitchell Ruchin	GSC	845-896-0288	GSC FSM

* Participated by teleconference.

Date of Session: 04/26/2011
Scoping Session Purpose: Review aquifer testing and groundwater quality monitoring results. Recommendations for long-term aquifer testing.

Name	**Affiliation**	**Phone #**	**Project Role**
Damian Duda	EPA	212-637-4269	EPA RPM
Grant Anderson *	EPA	212-6374326	EPA Technical
Kiera Becker	NYSDEC	518-402-9662	NYSDEC PM
Rich Reynolds *	USGS	518-285-5677	USGS PM
John Williams *	USGS	518-285-5670	USGS PD
Tom Morris	IBM	914-766-2739	IBM PM
Craig Robertson	GSC	717-574-5062	GSC PD
Dorothy Bergmann	GSC	845-896-0288	GSC PM
Mitchell Ruchin	GSC	845-896-0288	GSC FSM

* Participated by teleconference.

Date of Session: 05/23/2011
Scoping Session Purpose: Review long-term aquifer testing and groundwater quality monitoring results.

Name	**Affiliation**	**Phone #**	**Project Role**
Damian Duda	EPA	212-637-4269	EPA RPM
Grant Anderson *	EPA	212-6374326	EPA Technical
Rich Reynolds *	USGS	518-285-5677	USGS PM
John Williams *	USGS	518-285-5670	USGS PD
Tom Morris	IBM	914-766-2739	IBM PM
Craig Robertson	GSC	717-574-5062	GSC PD
Dorothy Bergmann	GSC	845-896-0288	GSC PM
Mitchell Ruchin	GSC	845-896-0288	GSC FSM

* Participated by teleconference.

Date of Session: 06/28/2011
Scoping Session Purpose: Review NTCSRA reporting..

Name	**Affiliation**	**Phone #**	**Project Role**
Damian Duda	EPA	212-637-4269	EPA RPM
Grant Anderson *	EPA	212-6374326	EPA Technical
Kiera Becker	NYSDEC	518-402-9662	NYSDEC PM
Kristin Kulow *	NYSDOH	607-432-3911	NYSDOH PM
Rich Reynolds *	USGS	518-285-5677	USGS PM
Tom Morris	IBM	914-766-2739	IBM PM
Craig Robertson	GSC	717-574-5062	GSC PD
Dorothy Bergmann	GSC	845-896-0288	GSC PM
Mitchell Ruchin	GSC	845-896-0288	GSC FSM

* Participated by teleconference.

Date of Session: 07/26/2011
Scoping Session Purpose: Review lithologic interpretations / USGS logging results..

Name	**Affiliation**	**Phone #**	**Project Role**
Damian Duda	EPA	212-637-4269	EPA RPM
Grant Anderson *	EPA	212-6374326	EPA Technical
Kiera Becker	NYSDEC	518-402-9662	NYSDEC PM
Rich Reynolds *	USGS	518-285-5677	USGS PM
Tom Morris	IBM	914-766-2739	IBM PM
Craig Robertson	GSC	717-574-5062	GSC PD
Dorothy Bergmann	GSC	845-896-0288	GSC PM

* Participated by teleconference.

Date of Session: 11/03/2011
Scoping Session Purpose: Review comprehensive round groundwater sampling results.

Name	**Affiliation**	**Phone #**	**Project Role**
Damian Duda	EPA	212-637-4269	EPA RPM
Kiera Becker	NYSDEC	518-402-9662	NYSDEC PM
Kristin Kulow *	NYSDOH	607-432-3911	NYSDOH PM
Rich Reynolds *	USGS	518-285-5677	USGS PM
Tom Morris	IBM	914-766-2739	IBM PM
Craig Robertson	GSC	717-574-5062	GSC PD
Matthew Luckman	GS, PC	717-645-2615	GSC PM
Dorothy Bergmann	GSC	845-896-0288	GSC PM
Mitchell Ruchin	GSC	845-896-0288	GSC FSM

* Participated by teleconference.

Date of Session: 12/13/2011
Scoping Session Purpose: Review comprehensive round groundwater sampling results and NTCSRA implementation.

Name	**Affiliation**	**Phone #**	**Project Role**
Damian Duda	EPA	212-637-4269	EPA RPM
Kiera Becker *	NYSDEC	518-402-9662	NYSDEC PM
Kristin Kulow *	NYSDOH	607-432-3911	NYSDOH PM
Rich Reynolds *	USGS	518-285-5677	USGS PM
Tom Morris	IBM	914-766-2739	IBM PM
Craig Robertson	GSC	717-574-5062	GSC PD
Dorothy Bergmann	GSC	845-896-0288	GSC PM
Mitchell Ruchin	GSC	845-896-0288	GSC FSM

* Participated by teleconference.

Date of Session: 01/31/2012
Scoping Session Purpose: Review USGS logging results. Identification of Candidate Technologies.

Name	**Affiliation**	**Phone #**	**Project Role**
Damian Duda	EPA	212-637-4269	EPA RPM
Diana Cutt *	EPA		EPA Technical
Charles Nace *	EPA		EPA Technical
Kiera Becker *	NYSDEC	518-402-9662	NYSDEC PM
Kristin Kulow *	NYSDOH	607-432-3911	NYSDOH PM
Rich Reynolds *	USGS	518-285-5677	USGS PM
Tom Morris	IBM	914-766-2739	IBM PM
Craig Robertson	GSC	717-574-5062	GSC PD
Dorothy Bergmann	GSC	845-896-0288	GSC PM
Charles Rine	GSC	717-901-8188	GSC PM
Mitchell Ruchin	GSC	845-896-0288	GSC FSM
Charles Stoner	GSC	845-896-0288	GSC Team Sci

* Participated by teleconference.

Date of Session: 03/06/2012
Scoping Session Purpose: USGS logging results and sampling interval selection.

Name	**Affiliation**	**Phone #**	**Project Role**
Damian Duda	EPA	212-637-4269	EPA RPM
Diana Cutt *	EPA		EPA Technical
Charles Nace *	EPA		EPA Technical
Kiera Becker *	NYSDEC	518-402-9662	NYSDEC PM
Kristin Kulow *	NYSDOH	607-432-3911	NYSDOH PM
John Williams	USGS	518-285-5670	USGS PD
Rich Reynolds	USGS	518-285-5677	USGS PM
Alton Andersen	USGS	518-285-5677	USGS Technical
Tom Morris	IBM	914-766-2739	IBM PM
Craig Robertson	GSC	717-574-5062	GSC PD
Dorothy Bergmann	GSC	845-896-0288	GSC PM
Charles Rine	GSC	717-901-8188	GSC PM
Mitchell Ruchin	GSC	845-896-0288	GSC FSM
Charles Stoner	GSC	845-896-0288	GSC Team Sci

* Participated by teleconference.

Date of Session: 03/27/2012 Scoping Session Purpose: Review final Core Boring Report. USGS logging results and sampling interval selection.			
Name	**Affiliation**	**Phone #**	**Project Role**
Damian Duda	EPA	212-637-4269	EPA RPM
Diana Cutt	EPA		EPA Technical
Charles Nace *	EPA		EPA Technical
Kiera Becker	NYSDEC	518-402-9662	NYSDEC PM
Kristin Kulow *	NYSDOH	607-432-3911	NYSDOH PM
John Williams	USGS	518-285-5670	USGS PD
Rich Reynolds	USGS	518-285-5677	USGS PM
Tom Morris	IBM	914-766-2739	IBM PM
Craig Robertson	GSC	717-574-5062	GSC PD
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Mitchell Ruchin	GSC	845-896-0288	GSC FSM

* Participated by teleconference.

Date of Session: 04/24/2012
Scoping Session Purpose: Review Pathway Analysis Report and Candidate Technology Memo.

Name	**Affiliation**	**Phone #**	**Project Role**
Damian Duda *	EPA	212-637-4269	EPA RPM
Charles Nace *	EPA		EPA Technical
Kiera Becker *	NYSDEC	518-402-9662	NYSDEC PM
Kristin Kulow *	NYSDOH	607-432-3911	NYSDOH PM
Tom Morris *	IBM	914-766-2739	IBM PM
Craig Robertson *	GSC	717-574-5062	GSC PD
Kathy Zvarick *	GSC		GSC PM
Dorothy Bergmann *	GSC	845-896-0288	GSC PM
Mitchell Ruchin *	GSC	845-896-0288	GSC FSM
Charles E. Stoner *	GSC	845-896-0288	GSC Sci

* Participated by teleconference.

Date of Session: 05/01/2012
Scoping Session Purpose: Review Retained Technology Options and Baseline Human Health Risk Assessment.

Name	**Affiliation**	**Phone #**	**Project Role**
Damian Duda *	EPA	212-637-4269	EPA RPM
Diana Cutt *	EPA		EPA Technical
Charles Nace *	EPA		EPA Technical
Kiera Becker *	NYSDEC	518-402-9662	NYSDEC PM
Kristin Kulow *	NYSDOH	607-432-3911	NYSDOH PM
Tom Morris *	IBM	914-766-2739	IBM PM
Craig Robertson *	GSC	717-574-5062	GSC PD
Dorothy Bergmann *	GSC	845-896-0288	GSC PM

* Participated by teleconference.

Date of Session: 05/15/2012
Scoping Session Purpose: Review USGS logging. results, Conceptual Site Model and Cross-sections.

Name	**Affiliation**	**Phone #**	**Project Role**
Damian Duda	EPA	212-637-4269	EPA RPM
Charles Nace	EPA		EPA Technical
Kiera Becker	NYSDEC	518-402-9662	NYSDEC PM
Kristin Kulow *	NYSDOH	607-432-3911	NYSDOH PM
Rich Reynolds *	USGS	518-285-5677	USGS PM
Alton Andersen *	USGS	518-285-5677	USGS Technical
Tom Morris	IBM	914-766-2739	IBM PM
Craig Robertson	GSC	717-574-5062	GSC PD
Dorothy Bergmann	GSC	845-896-0288	GSC PM
Michael Musso	HDR	845-735-8300	HDR Technical
Steve Seymour	HDR	201-316-1048	HDR Technical

* Participated by teleconference.

Date of Session: 05/29/2012
Scoping Session Purpose: Review USGS logging. results, Conceptual Site Model and Cross-sections.

Name	**Affiliation**	**Phone #**	**Project Role**
Damian Duda	EPA	212-637-4269	EPA RPM
Diana Cutt *	EPA		EPA Technical
David Crosby	NYSDEC	518-402-9662	NYSDEC PD
Kiera Becker	NYSDEC	518-402-9662	NYSDEC PM
Tom Morris	IBM	914-766-2739	IBM PM
Craig Robertson	GSC	717-574-5062	GSC PD
Dorothy Bergmann	GSC	845-896-0288	GSC PM
Charles E. Stoner *	GSC	845-896-0288	GSC Sci

* Participated by teleconference.

Date of Session: 06/12/2012
Scoping Session Purpose: Remedial Action Objectives and Remedial Alternative Screening Tables..

Name	**Affiliation**	**Phone #**	**Project Role**
Damian Duda	EPA	212-637-4269	EPA RPM
Kristin Kulow *	NYSDOH	607-432-3911	NYSDOH PM
Rich Reynolds *	USGS	518-285-5677	USGS PM
Alton Andersen *	USGS	518-285-5677	USGS Technical
Tom Morris	IBM	914-766-2739	IBM PM
Craig Robertson	GSC	717-574-5062	GSC PD
Charles Rine *	GSC	717-901-8188	GSC PM
Matthew Luckman *	GS, PC	717-645-2615	GSC PM
Dorothy Bergmann	GSC	845-896-0288	GSC PM
Charles E. Stoner	GSC	845-896-0288	GSC Sci
Jaak Vandensype	HDR	845-735-8300	HDR PD
Michael Musso	HDR	845-735-8300	HDR Technical
Steve Seymour	HDR	201-316-1048	HDR Technical

* Participated by teleconference.

Date of Session: 06/19/2012 Scoping Session Purpose: Remedial Investigation review.			
Name	**Affiliation**	**Phone #**	**Project Role**
Damian Duda	EPA	212-637-4269	EPA RPM
Sal Badalamente *	EPA		EPA PD
Charles Nace *	EPA		EPA Technical
David Crosby	NYSDEC	518-402-9662	NYSDEC PD
Kiera Becker	NYSDEC	518-402-9662	NYSDEC PM
Kristin Kulow *	NYSDOH	607-432-3911	NYSDOH PM
Tom Morris	IBM	914-766-2739	IBM PM
Craig Robertson	GSC	717-574-5062	GSC PD
Charles Rine *	GSC	717-901-8188	GSC PM
Matthew Luckman *	GS, PC	717-645-2615	GSC PM
Dorothy Bergmann	GSC	845-896-0288	GSC PM
Michael Musso	HDR	845-735-8300	HDR Technical
Steve Seymour	HDR	201-316-1048	HDR Technical

* Participated by teleconference.

Date of Session: 06/26/2012 Scoping Session Purpose: Remedial Investigation review, including review of monitoring data trends.			
Name	**Affiliation**	**Phone #**	**Project Role**
Damian Duda	EPA	212-637-4269	EPA RPM
Charles Nace *	EPA		EPA Technical
Kiera Becker *	NYSDEC	518-402-9662	NYSDEC PM
Kristin Kulow *	NYSDOH	607-432-3911	NYSDOH PM
Tom Morris	IBM	914-766-2739	IBM PM
Craig Robertson	GSC	717-574-5062	GSC PD
Charles Rine	GSC	717-901-8188	GSC PM
Matthew Luckman *	GS, PC	717-645-2615	GSC PM
Dorothy Bergmann	GSC	845-896-0288	GSC PM
Michael Musso	HDR	845-735-8300	HDR Technical
Steve Seymour	HDR	201-316-1048	HDR Technical

* Participated by teleconference.

Date of Session: 07/17/2012
Scoping Session Purpose: Remedial Investigation review. Review Baseline Human Health Risk Assessment.

Name	**Affiliation**	**Phone #**	**Project Role**
Damian Duda	EPA	212-637-4269	EPA RPM
Charles Nace *	EPA		EPA Technical
Kiera Becker Thompson *	NYSDEC	518-402-9662	NYSDEC PM
Kristin Kulow *	NYSDOH	607-432-3911	NYSDOH PM
Tom Morris	IBM	914-766-2739	IBM PM
Craig Robertson	GSC	717-574-5062	GSC PD
Charles Rine *	GSC	717-901-8188	GSC PM
Dorothy Bergmann	GSC	845-896-0288	GSC PM
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* Participated by teleconference.

Date of Session: 07/24/2012
Scoping Session Purpose: Remedial Investigation review and Feasibility Study.

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Date of Session: 07/31/2012
Scoping Session Purpose: Remedial Investigation review and Feasibility Study.

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Date of Session: 08/23/2012
Scoping Session Purpose: Remedial Investigation review. Feasibility Study.

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Date of Session: 07/10/2013
Scoping Session Purpose: Remedial Design / Remedial Action Work Plan

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Date of Session: 08/01/2013
Scoping Session Purpose: Remedial Design / Remedial Action Work Plan

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QAPP Worksheet #10: Problem Definitions

The problem to be addressed by the project: Shenandoah Road Groundwater Contamination Superfund Site History
The EPA and the New York State Department of Environmental Conservation (NYSDEC) together with the New York State Department of Health (NYSDOH) began a residential well sampling program in June 2000 in response to the detection of tetrachloroethene (PCE) in homeowner wells in the Shenandoah area of the Town of East Fishkill, Dutchess County, New York. These measures were undertaken as a federal removal action under CERCLA. Subsequently, EPA installed Point of Entry Treatment (POET) systems at 57 residences where PCE concentrations exceeded the federal Maximum Contaminant Level (MCL) of 5 ug/L. The total number of POET systems installed by the end of 2000 was 60.

In the fall of 2000, EPA determined the probable source of this contamination to be historical operations in a building located at EHCR7. EPA began a removal action for contaminated soil which continued through May 2001. The Site was added to the Superfund National Priorities List on June 14, 2001 (Superfund Identification Number: NYSFN0204269). The Site is also currently listed as a Class 2 Site (Site # 314104) in New York State Registry of Inactive Hazardous Waste Disposal Site.

Together with EPA, IBM under the Administrative Order on Consent for Removal Action, Index Number: CERCLA-02-2001-2020 (Removal AOC) completed the removal action for more than 10,000 tons of contaminated soil at the EHCR7 and EHCR11 parcels. In addition to this soil removal activity, other actions undertaken by IBM pursuant to the Removal AOC included: Installation of an additional 43 POET systems and operation, maintenance and monitoring of all 103 POET systems for a period of approximately nine years; Installation of a permanent public water supply to replace the use of individual residential supply wells, including a water source from the Town of Fishkill municipal system (a water main extending 7.5 miles to the Shenandoah Town Water District (STWD), and a distribution system serving 157 properties within the Shenandoah Town Water District); Installation, operation, maintenance and monitoring of the Source Extraction and Treatment System (SETS) at the Facility under the Non-Time Critical Source Removal Action (NTCSRA) for the purpose of controlling groundwater chemical flux from the remaining concentrated source in bedrock and to reduce mass contained in this source over time.

The remedial action objectives (RAOs) identified in the Feasibility Study Report and set forth in the ROD for the Site are based upon available information and standards such as applicable, relevant and appropriate requirements (ARARs) and risk-based levels established in the Baseline Human Health Risk Assessment (GSC and HDR, 2012). The specific RAOs identified for the Site are listed below:

> To restore groundwater to Maximum Contaminant Levels (MCLs) consisting of NYS Groundwater Quality Class GA Standards (6 NYCRR Part 703) of 5 µg/L for PCE, TCE and cis-1,2 DCE.
>
> To reduce and to control the residual DNAPL source in fractured gneiss bedrock beneath the EHCR7 and EHCR11 parcels and to prevent migration to the groundwater.
>
> To reduce VOC concentrations in the source area until the aquifer is attenuating sufficiently to achieve NYS MCLs.
>
> To prevent ingestion/direct contact of residential human receptors with groundwater having a concentration of PCE, TCE or cis-1,2 DCE or their degradation products which exceed NYSDOH Drinking Water Standards (10 NYCRR, Part 5, Subpart 5-1) of 5 µg/L for principal organic contaminants and with vapors derived from these contaminants in groundwater that may come to be present at significant concentrations.

The environmental questions being asked:
Is there sufficient evidence that the concentrations of the Site-related Constituents of Concern (COC) are decreasing in groundwater in the source area.

Are the concentrations of Site-related COCs in the groundwater plume area below the MCLs, specifically the NYS Groundwater Quality Class GA Standards (6 NYCRR Part 703) of 5 ug/L for PCE, TCE and cis-1,2-DCE.

Is the SETs reducing and controlling the residual DNAPL source in fractured gneiss bedrock beneath the EHCR7 and EHCR11 parcels to prevent migration to the groundwater.

Observations from any site reconnaissance reports:
Based on the occurrence of declining trends in some long-term residential monitoring wells, there is clear evidence that concentrations are naturally attenuating in some areas of the aquifer likely in response to the source removal work that was completed by EPA and IBM from 2000 to 2002. This is particularly the case in wells located north of the Facility along East Hook Cross Road and Shenandoah Road. From the observations of declining trends where they occur, it was concluded that in the absence of significant groundwater chemical flux from the source area, concentrations within the plume at this Site would diminish with time.

In discussing these observations with the EPA and the NYSDEC in 2010, agreement was reached on an approach to the conditions at this Site that entails two components. The first of these was to establish hydraulic control of the remaining source to prevent active chemical flux from the source to the plume, but more importantly to induce cleaner groundwater to flow through the remaining source material to substantially diminish primary and secondary source material. This component of the approach to this Site was to implemented as a removal action, pursuant to paragraph 41(f) of the Removal Order and IBM submitted a Non-Time-Critical Source Removal Action Statement of Work to EPA on February 9, 2010 which was approved by EPA on April 19, 2010.

The installation and construction tasks required to implement the SETS component of the selected remedy were completed as part of the NTCSRA with startup of the system occurring in March 2012. As such, this system was designed to control groundwater chemical flux from the source area and to diminish the DNAPL source in bedrock to levels that no longer require such control.

A synopsis of secondary data or information from site reports:
Groundwater chemistry data collected under the Remedial Investigation shows that transformation of PCE to its daughter products occurs primarily in the eastern portion of the plume. Groundwater flow from the apparent source area on the EHCR7 and EHCR11 parcels is strongly controlled by the structural features in the bedrock, which results in the plume being elongated along a north-south axis, and broadening to the north. Low PCE to TCE ratio portion of the plume attenuates in the vicinity of Jackson Road and Old Townsend Road, and the high ratio portion of the plume attenuates beneath Wetland HJ-54, both before reaching Stream No. 3.

From the data collected under the Remedial Investigation, there is also substantial evidence of natural attenuation of the concentrations of Site-related COCs in groundwater. Overall, concentrations in the plume drop by at least an order of magnitude from the apparent DNAPL source area (16,000 ug/L), to the nearby monitoring wells on Burbank Road (<1000 ug/L) and again by another order of magnitude as the plume crosses into the Paleozoic rocks and from there into the ice-contact deposits (<100 ug/L). Although the plume covers an area of 225 acres and extends in places to depths greater than 400 feet below ground surface, Site-related COCs in the plume are attenuated by various mechanisms such that no evidence exists that any of these substances has impacted any of the three streams draining the entire area of the Site.

The possible classes of contaminants and the affected matrices: Volatile Organic Compounds, specifically the Site-related Constituents of Concern (COC) are PCE and its degradation products, trichloroethylene (TCE) and cis-1,2-dichloroethylene (cis-1,2-DCE). Affected matrices include groundwater, surface water and sediments.

The rationale for inclusion of chemical and nonchemical analyses:
The remedy selected for this Site is Monitored Natural Attenuation (MNA) for the Groundwater Plume and Source Extraction and Treatment. Documentation for the selection of this remedy is provided in the EPA *Record of Decision for the Shenandoah Road Groundwater Contamination Superfund Site* (EPA, September 30, 2012) (ROD). Actions to implement this RD/RA Work Plan are being conducted pursuant to the United States Environmental Protection Agency Region 2 (EPA) Consent Decree for Remedial Action.

The purpose of the RD/RA Work Plan is to describe the selected remedy and to identify the steps to be taken to implement all components of the remedy including those previously designed and approved by EPA and those for which the design is described in this work plan for EPA’s review and approval. The goal of these efforts is to ensure that the remedial action objectives (RAOs) set forth in the ROD are met.

Sampling of groundwater, groundwater seeps, shallow Facility groundwater (Pit Water) surface water and sediments will be conducted as per the CMP. Analytical results will be validated and comparison of these validated results to the specific RAOs identified for the Site will determine if no further action is required, whether further sampling is warranted or whether further remedial action is needed to minimize current and potential exposures associated with Site COCs.

Sampling and analysis for these analytes will be performed as described in the CMP. This sampling will be conducted at those locations identified on Plate 4, which include: 26 groundwater monitoring wells/intervals, four extraction wells and four pit water monitoring pipes necessary to evaluate the effectiveness of the SETS component of the remedy; and 34 groundwater monitoring wells/intervals and one groundwater seep at the southern edge of NYSDEC Wetland HJ-54 necessary to monitor the effectiveness of the MNA component of the remedy.

Four surface water/sediment sampling locations have been identified for ongoing, routine monitoring in the southern portion of NYSDEC Wetland HJ-54. These sampling locations were selected because, together with the groundwater seep location mentioned above, they document the progressive reduction in COC concentrations in this wetland with distance from the groundwater seep area and as such are included in the MNA component of the CMP.

Information concerning various environmental indicators:
The maximum dimensions of the groundwater plume containing dissolved levels of PCE or one of its transformation products at a concentration greater than 5 ug/L are approximately 2,765 feet east to west by 5,580 feet north to south and covering a total area of approximately 225 acres or 0.35 square miles.
The identified source of this plume was historical operations involving VOC disposal in a building located on the 2.0-acre parcel at 7 East Hook Cross Road, labeled on Plate 2 in the west central portion of the map area. The plume emanating from this source extends north and south along Shenandoah Mountain and into valleys north and east of this ridge that are drained by the three unnamed tributaries to Gayhead Creek shown on Plate 2 (Stream Nos. 1-3), that are, nonetheless, beyond the limits of the plume.

Prior to the soil removal action at EHCR7 and EHCR11 in 2000-2002, PCE occurred at a maximum concentration in soil beneath these parcels of 11,000 mg/kg and in shallow groundwater (pit water) at 9900 ug/L. When that action was completed, post-excavation samples indicated the soil was successfully remediated to meet the soil cleanup goal of 1400 ug/kg. However, the results of the RI indicate the maximum concentration of PCE observed at the Site in groundwater is 16,000 ug/L in a well that monitors shallow bedrock groundwater believed to be affected by separate phase PCE that penetrated into the bedrock below these two parcels.

Beyond these two parcels, the maximum concentration of PCE in the plume observed during residential well sampling is 2100 ug/L. Concentrations in the northwestern portion of the plume have declined in some cases by more than an order of magnitude since the soil removal action was completed in 2002. Characterization sampling of soil gas, surface water and sediments have all confirmed crossover contamination in these media from VOCs dissolved in groundwater. The maximum concentrations of PCE in each of these media are as follows:

Soil gas:	11,000 ug/m3;
Surface Water:	60 ug/L in a groundwater seep discharge to the wetland north of I-84; and
Sediments:	3.7 ug/kg in sediments within that same wetland.

Plate 1 is a schematic conceptual site model (CSM) showing the principal transport pathway associated with the high ratio portion of the plume. This figure also shows callouts depicting a mechanism termed “matrix diffusion” by which Site-related COCs are “stored” in pore water within the solid bedrock adjoining fractures that convey groundwater flow or in rock fragments that make up the sand and gravel of the ice-contact aquifer. This process and a related process known as adsorption onto organic carbon in the bedrock and rock fragments of the sand and gravel represent what is termed “secondary source factors”. This results from the fact that as the groundwater concentrations decline in these aquifers, this “stored mass” moves back from the bedrock or rock fragments into the groundwater. The effect is to extend the time necessary to reach groundwater concentrations that meet regulatory limits. At this Site, secondary sourcing is believed to be much more significant in the ice-contact deposits than in the bedrock aquifers.

Plate 1 depicts VOC transport within a vapor-phase component of VOC mass in the subsurface. The development of the vapor phase results from two mechanisms: direct evaporation of VOCs from residual DNAPL in the vadose zone and volatilization of VOCs from groundwater at the water table. With the removal of the DNAPL-contaminated soil from the Facility, it is believed that the only remaining source of vapor phase transport is associated with volatilization from the water table as depicted on Plate 1.

Plate 1 also shows contaminated groundwater flux discharging to the wetland north of the plume, Wetland HJ-54. Where groundwater flux has discharged to surface water in Wetland HJ-54, data indicate that the concentrations in surface water are rapidly attenuated and decline to non-detect levels before reaching Stream No. 3. The Screening Level Ecological Risk Assessment (SLERA) has concluded that the resulting concentrations in the wetland do not constitute an unacceptable impact to ecological receptors.

QAPP Worksheet #11: Project Quality Objectives / Systematic Planning Process Statements

Who will use the data? EPA Region II
What will the data be used for? The groundwater, surface water and sediments sampling results for Volatile Organic Compounds, specifically the Site-related constituents of concern (COC) are PCE and its degradation products, trichloroethylene (TCE) and cis-1,2-dichloroethylene (cis-1,2-DCE). These data will be used by EPA Region II to determine if there is sufficient evidence that the concentrations of the Site-related Constituents of Concern (COC) are decreasing in groundwater in the source area; if the concentrations of Site-related COCs in the groundwater plume area below the MCLs (specifically the NYS Groundwater Quality Class GA Standards (6 NYCRR Part 703) of 5 ug/L for PCE, TCE and cis-1,2-DCE) and if the SETs is reducing and controlling the residual DNAPL source in fractured gneiss bedrock beneath the EHCR7 and EHCR11 parcels to prevent migration to the groundwater. Comparison of results with MCLs and statistical analysis of trends in the Site-related COC concentrations will assist EPA to determine if no further action is required, whether further sampling is warranted or whether additional remedial efforts are needed to minimize current and potential exposures with the Site COCs.
What type of data is needed? Groundwater, surface water and sediments quality data for Site-related COCs and parameters evidence of Hydraulic effectiveness data (water levels) to ascertain SETs Operational effectiveness data for the SETs
How "good" do the data need to be in order to support the environmental decision? Definitive laboratory data are required for data collected under the CMP. The quantitation levels are specified in Worksheet #15. All laboratory analyses will be performed by the TestAmerica Burlington and EnviroTest Laboratories. Worksheets #12 and #28 show the measurement performance criteria that are needed for the quality indicators. Worksheet #20 outlines the field quality control (QC) samples required. All definitive data will also be validated by Veridian QA/QC Chemists.
How much data are needed? As a result of scoping sessions and review of the Remedial Investigation results, sampling will be performed as described in the CMP. This sampling will be conducted at those locations identified on Plate 4, which include: 26 groundwater monitoring wells/intervals, four extraction wells and four pit water monitoring pipes necessary to evaluate the effectiveness of the SETS component of the remedy; and 34 groundwater monitoring wells/intervals and one groundwater seep at the southern edge of NYSDEC Wetland HJ-54 necessary to monitor the effectiveness of the MNA component of the remedy.

Where, when, and how should the data be collected/generated? Sampling and analysis for these analytes will be performed as described in the CMP. This sampling will be conducted at those locations identified on Plate 4, which include: 26 groundwater monitoring wells/intervals, four extraction wells and four pit water monitoring pipes necessary to evaluate the effectiveness of the SETS component of the remedy; and 34 groundwater monitoring wells/intervals and one groundwater seep at the southern edge of NYSDEC Wetland HJ-54 necessary to monitor the effectiveness of the MNA component of the remedy. Four surface water/sediment sampling locations have been identified for ongoing, routine monitoring in the southern portion of NYSDEC Wetland HJ-54. These sampling locations were selected because, together with the groundwater seep location mentioned above, they document the progressive reduction in COC concentrations in this wetland with distance from the groundwater seep area and as such are included in the MNA component of the CMP.
Who will collect and generate the data? Samples will be collected by GSC personnel and analyzed at outside laboratories.
How will the data be reported? Data will be disseminated to EPA Region II by GSC PM on an as needed basis and as per the Reporting schedules indicated in the RD/RA Work Plan. Validated data and statistical evaluations will be reported in reports prepared in accordance with the RD/RA Work Plan.
How will the data be archived? Hard copies of all deliverables will be stored in GSC Central Files and e-copies will be stored on GSC Local Area Network (LAN). Data will be imported into the site database and posted to the Sharefile or as otherwise requested. All data and analytical data packages will be archived by GSC.

QAPP Worksheet #12-1: Measurement Performance Criteria Table

Matrix	Soil / Surface Water / Groundwater
Analytical Group	Volatile Organic Compounds
Concentration Level	Low

Analytical Method SOP[1,2]	**Data Quality Indicators (DQIs)**	**QC Sample and/or Activity Used to Assess Measurement Performance**	**Measurement Performance Criteria**
EPA SW-846 Method 8260B SOP: BR-MV-006	Accuracy/Bias (Contamination)	Method Blank, Field Blanks	Concentration < RL (< 2x RL for methylene chloride, 2-butanone, acetone)
	Accuracy/Bias	Surrogates	Lab Limits
	Accuracy/Bias	Laboratory Control Sample	Lab Limits
	Accuracy/Bias, Precision	Matrix Spike/Matrix Spike Duplicates	Lab Limits
	Instrument Performance	Tune Standard	Table 4, SW-846, page 8260B-36 Prior to calibration and every 12 hours
	Accuracy	Initial Calibration	For chloromethane, 1,1-dichloroethane, bromoform, RRF ≥ 0.010. For chlorobenzene, 1,1,2,2-tetrachloroethane, RRF ≥ 0.030. For all other volatile compounds, RRF ≥ 0.050 Option 1. %RSD ≤ 30% for CCC compounds; %RSD ≤ 15% for all other volatile compounds Option 2: Linear regression r > 0.995.
	Accuracy	Initial Calibration Verification	% Difference 75-125%
	Accuracy	Continuing Calibrations	For chloromethane, 1,1-dichloroethane, bromoform, RRF ≥ 0.010. For chlorobenzene, 1,1,2,2-tetrachloroethane, RRF ≥ 0.030. For all other volatile compounds, RRF ≥ 0.050 % Difference/ Drift ± 20% for all compounds
	Instrument Performance	Internal Standards	Area between -50% to +100% of midpoint standard in the ICAL; RT ± 30.0 seconds of the midpoint standard of the ICAL
	Precision – Overall	Field Duplicate	RPD ≤ 30%
	Sensitivity	MDL	Low enough to support RL, MDL studies run annually

QAPP Worksheet #12-2: Measurement Performance Criteria Table

Matrix	Groundwater		
Analytical Group	Methane, Ethane, Ethylene, Carbon Dioxide		
Analytical Method SOP^{1,2}	**Data Quality Indicators (DQIs)**	**QC Sample and/or Activity Used to Assess Measurement Performance**	**Measurement Performance Criteria**
RSK-175 Dissolved Gases SOP: BR-AT-006	Accuracy/Bias (Contamination)	Method Blank	Concentration < RL
	Accuracy/Bias	Laboratory Control Sample	% Recovery 70-130%
	Precision/Accuracy	Matrix Spike/Matrix Spike Duplicates	% Recovery 70-130%, RPD < 30%
	Accuracy	Initial Calibration	RSD < 30%
	Accuracy	Initial Calibration Verification	% Difference 85-115%
	Accuracy	Continuing Calibrations	% Difference 85-115%
	Precision – Overall	Field Duplicate	RPD ≤ 30%
	Precision – Lab	Laboratory Duplicate	RPD ≤ 20%
	Sensitivity	MDL	Low enough to support RLs, MDL studies run annually

[1] Reference number from QAPP Worksheet #21
[2] Reference number from QAPP Worksheet #23

QAPP Worksheet #12-3: Measurement Performance Criteria Table

Matrix	Groundwater		
Analytical Group	Total Dissolved Solids		
Analytical Method SOP[1,2]	**Data Quality Indicators (DQIs)**	**QC Sample and/or Activity Used to Assess Measurement Performance**	**Measurement Performance Criteria**
SM 18-21 2540C Total Dissolved Solids SOP-TDS-1	Accuracy/Bias (Contamination)	Method Blank	Concentration < RL
	Accuracy/Bias	Laboratory Control Sample	% Recovery 77-122%
	Precision/Accuracy	Matrix Spike/Matrix Spike Duplicates	% Recovery 77-122%, RPD < 15%
	Precision – Overall	Field Duplicate	RPD ≤ 30%
	Precision – Lab	Laboratory Duplicate	RPD ≤ 15%

[1] Reference number from QAPP Worksheet #21
[2] Reference number from QAPP Worksheet #23

QAPP Worksheet #12-4: Measurement Performance Criteria Table

Matrix	Groundwater		
Analytical Group	Inorganics by Ion Chromatography		
Analytical Method SOP^{1,2}	**Data Quality Indicators (DQIs)**	**QC Sample and/or Activity Used to Assess Measurement Performance**	**Measurement Performance Criteria**
EPA 600/R93-100 Inorganics by Ion Chromatography SOP-IC-1	Accuracy/Bias (Contamination)	Method Blank, Field Blanks	Concentration < RL
	Accuracy/Bias	Laboratory Control Sample	Lab Limits
	Accuracy/Bias, Precision	Matrix Spike/Matrix Spike Duplicates	Lab Limits
	Accuracy	Initial Calibration	% Difference <10%
	Accuracy	Continuing Calibration Blank (CCB)	< Detection Limit
	Accuracy	Continuing Calibration Blank (CCV)	90-110%
	Precision – Laboratory	Duplicate	RPD < 20%
	Sensitivity	MDL	Low enough to support RL, MDL studies run annually

[1] Reference number from QAPP Worksheet #21
[2] Reference number from QAPP Worksheet #23

QAPP Worksheet #12-5: Measurement Performance Criteria Table

Matrix	Groundwater
Analytical Group	Metals
Concentration Level	Low

Analytical Method SOP[1,2]	**Data Quality Indicators (DQIs)**	**QC Sample and/or Activity Used to Assess Measurement Performance**	**Measurement Performance Criteria**
EPA 6010C and 200.7 Determination of Trace Elements by ICP-AES SOP: SOP-ICP-1	Accuracy/Bias (Contamination)	Method Blank, Field Blanks	Concentration < CRDL
	Accuracy/Bias	Laboratory Control Sample (LCSW)	85 -115% (Method 200.7) 80-120% (Method 6010C)
	Accuracy/Bias, Precision	Matrix Spike/Matrix Spike Duplicates	70-130% (Method 200.7) 75-125% (Method 6010C)
	Instrument Performance	ICSA (initial and final) Analyzed at the beginning and end of each analytical sequence	Al, Ca, Fe and Mg 80 – 120% All other elements absolute value ≤CRDL, if CDRL is ≤ 10ug/l absolute value should be ≤ 2Xs CRDL
	Accuracy	Initial Calibration	Linear regression R > 0.995.
	Accuracy	Initial Calibration Verification (ICV) 2nd Source	% Difference 95-105% (Method 200.7) % Difference 90-110% (Method 6010C)
	Accuracy	Continuing Calibration (CCV)	% Difference 90-110%
	Instrument Performance	ICSAB (initial and final) Analyzed at the beginning and end of each analytical sequence	80-120%
	Precision	Duplicate	Lab Limits RPD <20% if sample concentration >5x the CRDL. ± CRDL rule for sample conc. < 5x the CRDL. For a sample conc. < 5x the CRDL and a DUPLICATE result > 5x the CRDL, the ± rule is used.
	Sensitivity	MDL	Low enough to support RL, MDL studies at method startup, and then run annually

QAPP Worksheet #12-6: Measurement Performance Criteria Table

Matrix	Groundwater
Analytical Group	Metals
Concentration Level	Low

Analytical Method SOP^{1,2}	**Data Quality Indicators (DQIs)**	**QC Sample and/or Activity Used to Assess Measurement Performance**	**Measurement Performance Criteria**
EPA 6020A and 200.8 Determination of Trace Elements by ICP-AES SOP: SOP-ICP-1	Accuracy/Bias (Contamination)	Method Blank, Field Blanks	Concentration < CRDL
	Accuracy/Bias	Laboratory Control Sample (LCS)	85 -115% (Method 200.8); 80-120% (Method 6020A)
	Accuracy/Bias, Precision	Matrix Spike/Matrix Spike Duplicates	70-130% (Method 200.8); 75-125% (Method 6020A)
	Instrument Performance	ICSA/B (Daily at beginning of each analytical sequence for 6020A)	80-120% (Method 6020A)
	Accuracy	Initial Calibration	Linear regression R > 0.998.
	Accuracy	Initial Calibration Verification (ICV)	% Difference 90-110% (Method 6010C)
	Accuracy	Continuing Calibration (CCV)	% Difference 85-115% (Method 200.8) % Difference 90-110% (Method 6020A)
	Instrument Performance	Reporting Limit Calibration Check Standard (CRI) (Daily, if not part of calibration curve and at end of run for 6020A)	70-130% (Method 6020A)
	Precision	Duplicate	Lab Limits
	Sensitivity	MDL	Low enough to support RL, MDL studies at method startup, and then run annually
	Instrument Performance	Daily Performance Standard Tuning	Laboratory Limits see SOP

QAPP Worksheet #12-7: Measurement Performance Criteria Table

Matrix	Soil (Sediments)		
Analytical Group	Total Organic Carbon		
Analytical Method/ SOP[1,2]	**Data Quality Indicators (DQIs)**	**QC Sample and/or Activity Used to Assess Measurement Performance**	**Measurement Performance Criteria**
Total Organic Carbon by Lloyd Kahn Method	Accuracy/Bias (Contamination)	Method Blank Calibration Blank	Concentration < RL
	Accuracy/Bias	Laboratory Control Samples	% Recovery 75-125%
	Precision/Accuracy	Matrix Spike/Matrix Spike Duplicates	% Recovery 75-125%
	Accuracy	Initial Calibration	r-value ≥ 0.995
	Accuracy	Initial Calibration Verification	% Difference 85-115%
	Accuracy	Continuing Calibrations	% Difference 85-115%
	Precision – Overall	Field Duplicate	RPD ≤ 30%
	Precision – Lab	Laboratory Duplicate	RPD ≤ 20%, Analyze two or more duplicates and perform Dixon Outlier Test, per Laboratory SOP
	Sensitivity	MDL	Low enough to support RL, MDL studies run annually

[1] Reference number from QAPP Worksheet #21
[2] Reference number from QAPP Worksheet #23

QAPP Worksheet #13: Secondary Data Criteria and Limitations Table

Secondary Data	Data Source (Originating Organization, Report Title, and Date)	Data Generator(s) (Originating Org., Data Types, Data Generation/ Collection Dates)	How Data Will Be Used	Limitations on Data Use ?
Former Domestic Well Water Quality Results	Point of Entry Treatment System monitoring and Residential Well Sampling Program pursuant to Administrative Order No. 02-2001-2020 as reported on in the *Remedial Investigation Report for the Shenandoah Road Groundwater Contamination Superfund Site*, August 15, 2012	2000 to 2001: EPA,NYSDEC & NYSDOH 2002 to 2009: GSC	To assess trends of Site COCs.	None
Former Domestic Well Lithologic Interpretations	*Remedial Investigation Report for the Shenandoah Road Groundwater Contamination Superfund Site*, August 15, 2012	2008 to 2013: USGS geophysical logging results	Well construction details and well sampling methods.	None
Removal Action Media Monitoring Results	Media monitoring data collected pursuant to Administrative Order No. 02-2001-2020 as reported on in the *Final Report for the Removal Action at 7 East Hook Cross Road Facility*, December 18, 2002 and the *Remedial Investigation Report for the Shenandoah Road Groundwater Contamination Superfund Site*, August 15, 2012	2000 to 2002: EPA, NYSDEC and GSC	Baseline conditions	None
Remedial Investigation Media Monitoring Results	Media monitoring data collected pursuant to Administrative Order No. 02-2002-2025 as reported on in the *Remedial Investigation Report for the Shenandoah Road Groundwater Contamination Superfund Site*, August 15, 2012	2001 to present: GSC, HDR	To assess trends of Site COCs.	None

QAPP Worksheet #14: Summary of Project Tasks

Sampling Tasks:
The collection of groundwater, groundwater seep, shallow facility pit water, surface water and sediments and using GSC Sampling SOP and in accordance with the sampling schedules presented in Worksheet #18. Samples will also be collected to ascertain the effectiveness of the SETS

Analysis Tasks:
Analysis of all samples collected as part of the CMP will be in accordance with the schedules presented in Worksheet #18 and the methodology presented in Worksheet #19 and include the following analytical groups:
Volatile Organic Compounds by SW-846 Method 8260C
Dissolved Gases and Carbon Dioxide by RSK-175
Metals by SW-846 Method 6010A and 6010C
Total Dissolved Solids by SM 18-21 2540C
Nitrate, as Nitrogen by EPA 600R93-100
Dissolved Oxygen b SM4500 CO
Percent Moisture (sediments only)
Total Organic Carbon (sediments only) by Lloyd Kahn

Quality Control Tasks:
Field QC samples will be collected as per the sampling frequency noted in Worksheet #20. A unique sample identification system will be used for all trip blanks, equipment blanks and duplicates. All containers from one sample will be labeled with this unique identification number (FieldID) as per GSC Sampling SOP, Section 8.0. Field sampling data will be recorded on field data sheets or in field books. Analytical data will be imported into a database via electronic data deliverables (EDDs) comma separated value files supplied by Veridian for definitive data. Analytical QC samples will be analyzed in accordance with Worksheets 12 & 28. All QC samples are referenced in GSC Sampling SOP, Section 7.0, *Field Quality Assurance/Quality Control Requirements.*

Secondary Data: N/A.

Data Management Tasks:
All sampling locations will be identified by a field assigned number (see Worksheet #18, LocationID). A unique sample identification system will be used for all trip blanks, equipment blanks, duplicates, and environmental samples. All containers from one sample will be labeled with this unique identification number (FieldID) as per GSC Sampling SOP, Section 8.0. Field sampling data will be recorded on field data sheets or in field books. Analytical data will be imported into a database via electronic data deliverables (EDDs) comma separated value files supplied by Veridian for definitive data.

Documentation and Records:
All documentation will be recorded in accordance with GSC Sampling SOP, Section 8.0, *Sampling Documentation*. All Analytical Reports will be prepared in accordance with project requirements. Documents and records that may be generated during this project include: the Remedial Design / Remedial Action Work Plan; the Comprehensive Monitoring Plan (CMP); Operations, Maintenance and Monitoring Manual (OM&M Manual); Quality Assurance Project Plan (QAPP); Health and Safety / Contingency Plan (HSCP); Field and Laboratory Logbooks; Site Map; Sample Labels; COC Records; Custody Seals; Data Review Records; Data Reduction Records; Data Assessment Forms; Data Validation Records; Instrument Printouts; Database; Analytical Reports. All deliverables will be generated in accordance to the appropriate SOP and will be distributed upon completion.

Assessment/Audit Tasks:
Performance audits of field operations and laboratory practice are anticipated for this project and will be carried out in accordance with the schedule presented in Worksheet #31. The tasks associated with this QAPP are assessed using peer reviews and management system reviews. Peer review enables the field team to identify and correct reporting errors before reports are submitted. Management system reviews establish compliance with prevailing management structure, policies and procedures, and ensures that the required data are obtained.

Data Review Tasks:
Laboratory procedures will be reviewed and the data verified for the appropriate quality assurance objectives. Analytical data will be validated in accordance with procedures detailed in Worksheet #37. All project deliverables will receive an internal peer review prior to release.

QAPP Worksheet #15-1: Reference Limits and Evaluation Table

Matrix: Aqueous
Analytical Group: Volatile Organic Compounds

Analyte	CAS Number	Project Action Limit (PAL)	Project Quantitation Limit Goal (ug/L)	Analytical Method: SW846 8260B Laboratory-specific		
				QLs (ug/L)	LODs (ug/L)	DLs (ug/L)
1,1,1,2-Tetrachloroethane	630-20-6	NS	1.0	1	0.25	0.16
1,1,1-Trichloroethane	71-55-6	NS	1.0	1	0.25	0.19
1,1,2,2-Tetrachloroethane	79-34-5	NS	1.0	1	0.25	0.15
Freon TF	76-13-1	NS	1.0	1	0.25	0.22
1,1,2-Trichloroethane	79-00-5	NS	1.0	1	0.5	0.35
1,1-Dichloroethane	75-34-3	NS	1.0	1	0.25	0.15
1,1-Dichloroethene	75-35-4	NS	1.0	1	0.25	0.21
1,1-Dichloropropene	563-58-6	NS	1.0	1	0.25	0.21
1,2,3-Trichlorobenzene	87-61-6	NS	1.0	1	0.5	0.28
1,2,3-Trichloropropane	96-18-4	NS	1.0	1	0.25	0.21
1,2,4-Trichlorobenzene	120-82-1	NS	1.0	1	0.25	0.23
1,2,4-Trimethylbenzene	95-63-6	NS	1.0	1	0.25	0.17
1,2-Dibromo-3-Chloropropane	96-12-8	NS	1.0	1	0.5	0.37
1,2-Dibromoethane	106-93-4	NS	1.0	1	0.25	0.15
1,2-Dichlorobenzene	95-50-1	NS	1.0	1	0.25	0.11
1,2-Dichloroethane	107-06-2	NS	1.0	1	0.25	0.2
1,2-Dichloropropane	78-87-5	NS	1.0	1	0.25	0.18
1,3,5-Trimethylbenzene	108-67-8	NS	1.0	1	0.25	0.17
1,3-Dichlorobenzene	541-73-1	NS	1.0	1	0.25	0.14
1,3-Dichloropropane	142-28-9	NS	1.0	1	0.25	0.17
1,4-Dioxane	123-91-1	NS	50	50	25	11
1,4-Dichlorobenzene	106-46-7	NS	1.0	1	0.25	0.19
2,2-Dichloropropane	594-20-7	NS	1.0	1	0.5	0.28
2-Butanone	78-93-3	NS	5.0	5	1.3	1.2
2-Chloroethyl vinyl ether	110-75-8	NS	1.0	1	0.5	0.26
2-Chlorotoluene	95-49-8	NS	1.0	1	0.25	0.17
2-Hexanone	591-78-6	NS	5.0	5	1.3	0.46
4-Chlorotoluene	106-43-4	NS	1.0	1	0.25	0.18
4-Isopropyltoluene	99-87-6	NS	1.0	1	0.25	0.22
4-Methyl-2-pentanone	108-10-1	NS	5.0	5	1.3	0.45
Acetone	67-64-1	NS	5.0	5	1.3	0.49
Benzene	71-43-2	NS	1.0	1	0.25	0.15
Bromobenzene	108-86-1	NS	1.0	1	0.25	0.15
Bromoform	75-25-2	NS	1.0	1	0.25	0.18
Bromomethane	74-83-9	NS	1.0	1	0.5	0.3
Carbon tetrachloride	56-23-5	NS	1.0	1	0.25	0.18
Chlorobenzene	108-90-7	NS	1.0	1	0.25	0.15
Dibromochloromethane	124-48-1	NS	1.0	1	0.25	0.17
Chloroethane	75-00-3	NS	1.0	1	0.5	0.26
Chloromethane	74-87-3	NS	1.0	1	0.25	0.22

Analyte	CAS Number	Project Action Limit (PAL)	Project Quantitation Limit Goal (ug/L)	Analytical Method: SW846 8260B Laboratory-specific		
				QLs (ug/L)	LODs (ug/L)	DLs (ug/L)
Chloroform	67-66-3	NS	1.0	1	0.25	0.2
cis-1,2-Dichloroethene	156-59-2	NS	1.0	1	0.25	0.24
cis-1,3-Dichloropropene	10061-01-5	NS	1.0	1	0.25	0.14
Cyclohexane	110-82-7	NS	1.0	1	0.25	0.17
Dibromomethane	74-95-3	NS	1.0	1	0.25	0.14
Bromochloromethane	74-97-5	NS	1.0	1	0.25	0.13
Bromodichloromethane	75-27-4	NS	1.0	1	0.25	0.16
Dichlorodifluoromethane	75-71-8	NS	1.0	1	0.25	0.23
Methylene Chloride	75-09-2	NS	1.0	1	0.25	0.17
Ethylbenzene	100-41-4	NS	1.0	1	0.25	0.19
Hexachlorobutadiene	87-68-3	NS	1.0	1	0.5	0.26
Methyl iodide	74-88-4	NS	1.0	1	0.5	0.36
Isobutyl alcohol	78-83-1	NS	50	50	13	7.1
Isopropylbenzene	98-82-8	NS	1.0	1	0.25	0.16
Methyl acetate	79-20-9	NS	1.0	1	0.5	0.23
Methyl t-butyl ether	1634-04-4	NS	1.0	1	0.25	0.17
m&p-Xylene	179601-23-1	NS	1.0	1	0.5	0.32
Naphthalene	91-20-3	NS	1.0	1	0.5	0.31
n-Butylbenzene	104-51-8	NS	1.0	1	0.25	0.23
n-Propylbenzene	103-65-1	NS	1.0	1	0.25	0.2
o-Xylene	95-47-6	NS	1.0	1	0.25	0.16
sec-Butylbenzene	135-98-8	NS	1.0	1	0.25	0.18
Styrene	100-42-5	NS	1.0	1	0.25	0.15
tert-Butylbenzene	98-06-6	NS	1.0	1	0.25	0.17
Tetrachloroethene	127-18-4	NS	1.0	1	0.25	0.18
Tetrahydrofuran	109-99-9	NS	14	14	3.5	1.8
Toluene	108-88-3	NS	1.0	1	0.25	0.16
trans-1,2-Dichloroethene	156-60-5	NS	1.0	1	0.25	0.24
trans-1,3-Dichloropropene	10061-02-6	NS	1.0	1	0.25	0.16
Trichloroethene	79-01-6	NS	1.0	1	0.25	0.2
Trichlorofluoromethane	75-69-4	NS	1.0	1	0.25	0.19
Vinyl acetate	108-05-4	NS	1.0	1	0.25	0.21
Vinyl chloride	75-01-4	NS	1.0	1	0.25	0.24
Xylenes, Total	1330-20-7	NS	1.0	1	0.75	0.48
Carbon disulfide	75-15-0	NS	1.0	1	0.5	0.42
Methylcyclohexane	108-87-2	NS	1.0	1	0.25	0.17
1,2-Dichloroethane-d4 (Surrogate)	17060-07-0	NA	NA	NA	NA	NA
Toluene-d8 (Surrogate)	2037-26-5	NA	NA	NA	NA	NA
Bromofluorobenzene (Surrogate)	460-00-4	NA	NA	NA	NA	NA
1,2-Dichlorobenzene-d4 (Surrogate)	2199-69-1	NA	NA	NA	NA	NA

NS = not specified, NA = not applicable ug/L = micrograms per liter

QAPP Worksheet #15-2: Reference Limits and Evaluation Table

Matrix: Solid / Sediment
Analytical Group: Volatile Organic Compounds

Analyte	CAS Number	Project Action Limit (PAL)	Project Quantitation Limit Goal (ug/Kg)	Analytical Method: SW846 8260B Laboratory-specific		
				QLs (ug/Kg)	LODs (ug/Kg)	DLs (ug/Kg)
1,1,1,2-Tetrachloroethane	630-20-6	NS	5.0	5	0.25	0.13
1,1,1-Trichloroethane	71-55-6	NS	5.0	5	1	0.7
1,1,2,2-Tetrachloroethane	79-34-5	NS	5.0	5	0.5	0.26
Freon TF	76-13-1	NS	5.0	5	0.5	0.33
1,1,2-Trichloroethane	79-00-5	NS	5.0	5	0.5	0.34
1,1-Dichloroethane	75-34-3	NS	5.0	5	0.5	0.41
1,1-Dichloroethene	75-35-4	NS	5.0	5	0.5	0.37
1,1-Dichloropropene	563-58-6	NS	5.0	5	1	0.93
1,2,3-Trichlorobenzene	87-61-6	NS	5.0	5	0.25	0.15
1,2,3-Trichloropropane	96-18-4	NS	5.0	5	0.5	0.3
1,2,4-Trichlorobenzene	120-82-1	NS	5.0	5	0.25	0.2
1,2,4-Trimethylbenzene	95-63-6	NS	5.0	5	0.25	0.18
1,2-Dibromo-3-Chloropropane	96-12-8	NS	5.0	5	1	0.91
1,2-Dibromoethane	106-93-4	NS	5.0	5	0.25	0.15
1,2-Dichlorobenzene	95-50-1	NS	5.0	5	0.25	0.22
1,2-Dichloroethane	107-06-2	NS	5.0	5	1	0.62
1,2-Dichloropropane	78-87-5	NS	5.0	5	0.5	0.29
1,3,5-Trimethylbenzene	108-67-8	NS	5.0	5	0.25	0.18
1,3-Dichlorobenzene	541-73-1	NS	5.0	5	0.25	0.15
1,3-Dichloropropane	142-28-9	NS	5.0	5	0.25	0.19
1,4-Dioxane	123-91-1	NS	250	250	25	23
1,4-Dichlorobenzene	106-46-7	NS	5.0	5	0.25	0.23
2,2-Dichloropropane	594-20-7	NS	5.0	5	0.5	0.43
2-Butanone	78-93-3	NS	5.0	5	2.5	1.5
2-Chloroethyl vinyl ether	110-75-8	NS	5.0	5	1	0.53
2-Chlorotoluene	95-49-8	NS	5.0	5	0.25	0.14
2-Hexanone	591-78-6	NS	5.0	5	0.5	0.49
4-Chlorotoluene	106-43-4	NS	5.0	5	0.5	0.35
4-Isopropyltoluene	99-87-6	NS	5.0	5	0.25	0.12
4-Methyl-2-pentanone	108-10-1	NS	5.0	5	1	0.6
Acetone	67-64-1	NS	5.0	5	1	1
Benzene	71-43-2	NS	5.0	5	1	0.71
Bromobenzene	108-86-1	NS	5.0	5	0.1	0.087
Bromoform	75-25-2	NS	5.0	5	0.25	0.2
Bromomethane	74-83-9	NS	5.0	5	1	0.74
Carbon tetrachloride	56-23-5	NS	5.0	5	1	0.76
Chlorobenzene	108-90-7	NS	5.0	5	0.1	0.076
Dibromochloromethane	124-48-1	NS	5.0	5	0.25	0.11

Analyte	CAS Number	Project Action Limit (PAL)	Project Quantitation Limit Goal (ug/Kg)	Analytical Method: SW846 8260B Laboratory-specific		
				QLs (ug/Kg)	LODs (ug/Kg)	DLs (ug/Kg)
Chloroethane	75-00-3	NS	5.0	5	0.5	0.38
Chloromethane	74-87-3	NS	5.0	5	0.5	0.26
Chloroform	67-66-3	NS	5.0	5	0.5	0.32
cis-1,2-Dichloroethene	156-59-2	NS	5.0	5	0.5	0.42
cis-1,3-Dichloropropene	10061-01-5	NS	5.0	5	0.5	0.35
Cyclohexane	110-82-7	NS	5.0	5	1	0.85
Dibromomethane	74-95-3	NS	5.0	5	0.5	0.27
Bromochloromethane	74-97-5	NS	5.0	5	0.5	0.37
Bromodichloromethane	75-27-4	NS	5.0	5	0.25	0.21
Dichlorodifluoromethane	75-71-8	NS	5.0	5	0.25	0.23
Methylene Chloride	75-09-2	NS	5.0	5	1	0.55
Ethylbenzene	100-41-4	NS	5.0	5	0.1	0.056
Hexachlorobutadiene	87-68-3	NS	5.0	5	0.25	0.17
Methyl iodide	74-88-4	NS	5.0	5	0.5	0.31
Isobutyl alcohol	78-83-1	NS	250	250	50	49
Isopropylbenzene	98-82-8	NS	5.0	5	0.1	0.077
Methyl acetate	79-20-9	NS	5.0	5	1	0.63
Methyl t-butyl ether	1634-04-4	NS	5.0	5	0.5	0.3
m&p-Xylene	179601-23-1	NS	5.0	5	1	0.7
Naphthalene	91-20-3	NS	5.0	5	0.5	0.26
n-Butylbenzene	104-51-8	NS	5.0	5	0.25	0.19
n-Propylbenzene	103-65-1	NS	5.0	5	0.25	0.11
o-Xylene	95-47-6	NS	5.0	5	0.1	0.061
sec-Butylbenzene	135-98-8	NS	5.0	5	0.1	0.089
Styrene	100-42-5	NS	5.0	5	0.25	0.1
tert-Butylbenzene	98-06-6	NS	5.0	5	0.25	0.1
Tetrachloroethene	127-18-4	NS	5.0	5	0.25	0.11
Tetrahydrofuran	109-99-9	NS	50	50	10	6.1
Toluene	108-88-3	NS	5.0	5	0.25	0.1
trans-1,2-Dichloroethene	156-60-5	NS	5.0	5	0.5	0.37
trans-1,3-Dichloropropene	10061-02-6	NS	5.0	5	0.25	0.13
Trichloroethene	79-01-6	NS	5.0	5	0.5	0.48
Trichlorofluoromethane	75-69-4	NS	5.0	5	0.5	0.33
Vinyl acetate	108-05-4	NS	5.0	5	1	0.7
Vinyl chloride	75-01-4	NS	5.0	5	0.5	0.3
Xylenes, Total	1330-20-7	NS	5.0	5	0.75	0.73
Carbon disulfide	75-15-0	NS	5.0	5	0.5	0.31
Methylcyclohexane	108-87-2	NS	5.0	5	0.25	0.17
1,2-Dichloroethane-d4 (Surrogate)	17060-07-0	NA	NA	NA	NA	NA
Toluene-d8 (Surrogate)	2037-26-5	NA	NA	NA	NA	NA
Bromofluorobenzene (Surrogate)	460-00-4	NA	NA	NA	NA	NA
1,2-Dichlorobenzene-d4 (Surrogate)	2199-69-1	NA	NA	NA	NA	NA

NS = not specified, NA = not applicable ugKg = micrograms per kilogram

QAPP Worksheet #15-3: Reference Limits and Evaluation Table

Matrix: Aqueous
Analytical Group: Dissolved Gases

Analyte	CAS Number	Project Action Limit (PAL)	Project Quantitation Limit Goal (ug/L)	Analytical Method:RSK-175 Laboratory-specific		
				QLs (ug/L)	LODs (ug/L)	DLs (ug/L)
Carbon Dioxide	124-38-9	NS	1000	1000	NA	86
Methane	74-82-8	NS	2	2	NA	0.21
Ethane	74-84-0	NS	4	4	NA	0.42
Ethylene	74-85-1	NS	3	3	NA	0.42

NS = not specified, NA = not applicable ug/L = micrograms per liter

QAPP Worksheet #15-4: Reference Limits and Evaluation Table

Matrix: Soil / Sediment
Analytical Group: Total Organic Carbon

Analyte	CAS Number	Project Action Limit	Project Quantitation Limit Goal (mg/Kg)	Analytical Method: Lloyd Kahn Laboratory-specific	
				QLs (mg/Kg)	DLs (mg/Kg)
Total Organic Carbon	7440-44-0	NS	1000	1000	109.0

NS = not specified, NA = not applicable mg/Kg = milligrams per kilogram

QAPP Worksheet #16: Project Schedule Timeline Table

Activities	Organization	Anticipated Date(s) of Initiation	Deliverable	Deliverable Due Date
Field Activities	GSC	Quarterly CMP: Groundwater, Pit Water, Groundwater Seeps, Surface Water & Sediments Monthly SETs: Source Extraction Wells and Performance Monitoring of the Treatment System	No	NA
Sample Analysis	TestAmerica-Burlington EnviroTest Laboratories	Upon receipt of Site Samples	Preliminary Analytical Results	15Business Days (BD) after receipt of samples
Preparation of Analytical Data Package	TestAmerica-Burlington EnviroTest Laboratories	Upon completion of analytical requirements	Final Data Package	20 BD after receipt of samples
Data Validation/Preparation of Analytical Report & EDD	Veridian	Upon receipt of Final Data Package	Final Analytical Report	30 BD after receipt of Data Package

QAPP Worksheet #17: Sampling Design and Rationale

Describe and provide a rationale for choosing the sampling approach (e.g., grid system, biased statistical approach):
Sampling locations, monitoring parameters and sampling frequencies are duplicated from Alternative #2 of the Feasibility Study. Original sampling locations were determined by the EPA Region II RPM. Additional sampling locations will be determined by the EPA Region II RPM based on five-year reviews.

Describe the sampling design and rationale in terms of what matrices will be sampled, what analytical groups will be analyzed and at what concentration levels, the sampling locations (including QC, critical, and background samples), the number of samples to be taken, and the sampling frequency (including seasonal considerations) [Refer to Worksheet #18 for details]:
As a result of scoping sessions and review of the Remedial Investigation results, sampling will be performed as described in the CMP. This sampling will be conducted at those locations identified on Plate 4, which include: 26 groundwater monitoring wells/intervals, four extraction wells and four pit water monitoring pipes necessary to evaluate the effectiveness of the SETS component of the remedy; and 34 groundwater monitoring wells/intervals and one groundwater seep at the southern edge of NYSDEC Wetland HJ-54 necessary to monitor the effectiveness of the MNA component of the remedy. In addition, surface water and sediment sampling will occur at the four locations shown on Plate 4.

QAPP Worksheet #18-1: Sampling Locations and Methods/SOP Requirements (Years 1-5)

Monitoring Years 1 -5								
Sampling Location/ID Number		**Matrix[1]**	**Location ID**	**Analytical Group(s)**	**Concentration Level**	**Sampling Frequency per Year[2]**	**Sampling SOP Reference[3]**	**Rationale for Sampling Location[4]**
Groundwater Monitoring								
SRMW-1RC		GW	S01C030	VOC MNA Parameters	LOW	S *	GSC SOP	SETS, MNA
SRMW-2RA		GW	S02A240	VOC MNA Parameters	LOW	S *	GSC SOP	SETS
SRMW-11R	Port 4	GW	S11R315	VOC MNA Parameters	LOW	S *	GSC SOP	MNA
SRMW-12S		GW	S12S019	VOC MNA	LOW	Q *	GSC SOP	MNA
SRMW-12RA		GW	S12RA250	VOC MNA Parameters	LOW	Q *	GSC SOP	MNA
SRMW-12RB		GW	S12RB118	VOC MNA Parameters	LOW	S *	GSC SOP	MNA
SRMW-12RC		GW	S12RC270	VOC	LOW	A	GSC SOP	GW PLUME
SRMW-14S		GW	S14S027	VOC MNA Parameters	LOW	Q *	GSC SOP	MNA
SRMW-14R	Port 1	GW	S14R150	VOC MNA Parameters	LOW	S *	GSC SOP	MNA
	Port 2	GW	S14R364	VOC	LOW	A	GSC SOP	SETS
SRMW-14RA		GW	S14A120	VOC MNA Parameters	LOW	S *	GSC SOP	MNA
SRMW-14RB		GW	S14B090	VOC MNA Parameters	LOW	Q *	GSC SOP	MNA
SRMW-15R	Port 2	GW	S15R197	VOC MNA Parameters	LOW	A *	GSC SOP	MNA
	Port 3	GW	S15R320	VOC MNA Parameters	LOW	S *	GSC SOP	MNA
	Port 4	GW	S15R340	VOC MNA Parameters	LOW	Q *	GSC SOP	MNA
SRMW-16R	Port 1	GW	S16R038	VOC	LOW	A	GSC SOP	GW PLUME

Monitoring Years 1 -5

Sampling Location/ID Number		Matrix[1]	Location ID	Analytical Group(s)	Concentration Level	Sampling Frequency per Year[2]	Sampling SOP Reference[3]	Rationale for Sampling Location[4]
	Port 2	GW	S16R130	VOC	LOW	A	GSC SOP	GW PLUME
	Port 3	GW	S16R300	VOC MNA Parameters	LOW	Q *	GSC SOP	MNA
SRMW-17R	Port 2	GW	S17R087	VOC	LOW	A	GSC SOP	SETS
	Port 3	GW	S17R139	VOC MNA Parameters	LOW	S *	GSC SOP	SETS, MNA
	Port 4	GW	S17R163	VOC	LOW	Q	GSC SOP	SETS
	Port 5	GW	S17R230	VOC MNA Parameters	LOW	S *	GSC SOP	SETS, MNA
	Port 6	GW	S17R312	VOC	LOW	A	GSC SOP	SETS
	Port 7	GW	S17R413	VOC MNA Parameters	LOW	Q *	GSC SOP	SETS, MNA
SRMW-18RD		GW	S18D247	VOC MNA Parameters	LOW	Q *	GSC SOP	SETS, MNA
SRMW-18RF	Port 1	GW	S18F420	VOC MNA Parameters	LOW	S *	GSC SOP	SETS, MNA
BRB003		GW	BRB003	VOC MNA Parameters	LOW	Q *	GSC SOP	SETS, MNA
BRB005	Shallow	GW	BRB005-S	VOC MNA Parameters	LOW	S *	GSC SOP	SETS, MNA
	Deep	GW	BRB005-D	VOC MNA Parameters	LOW	Q *	GSC SOP	SETS, MNA
BRB006	Shallow	GW	BRB006-S	VOC MNA Parameters	LOW	S *	GSC SOP	SETS, MNA
	Deep	GW	BRB006-D	VOC MNA Parameters	LOW	Q *	GSC SOP	SETS, MNA
BRB007	Shallow	GW	BRB007-S	VOC	LOW	S	GSC SOP	SETS, MNA
	Deep	GW	BRB007-D	VOC	LOW	Q	GSC SOP	SETS, MNA
BRB009	Shallow	GW	BRB009-S	VOC	LOW	S	GSC SOP	SETS
	Deep	GW	BRB009-D	VOC MNA Parameters	LOW	Q *	GSC SOP	SETS, MNA

Monitoring Years 1 -5

Sampling Location/ID Number		Matrix[1]	Location ID	Analytical Group(s)	Concentration Level	Sampling Frequency per Year[2]	Sampling SOP Reference[3]	Rationale for Sampling Location[4]
BRB011	Shallow	GW	BRB011-S	VOC	LOW	S	GSC SOP	SETS
	Deep	GW	BRB011-D	VOC MNA Parameters	LOW	Q *	GSC SOP	SETS, MNA
EHC002	Deep	GW	EHC002-D	VOC MNA Parameters	LOW	S *	GSC SOP	SETS, MNA
EHC009		GW	EHC009	VOC	LOW	A	GSC SOP	SETS
EHC017		GW	EHC017	VOC	LOW	A	GSC SOP	SETS
GRF006		GW	GRF006	VOC	LOW	A	GSC SOP	GW PLUME
GRF007		GW	GRF007	VOC	LOW	A	GSC SOP	GW PLUME
JCK117		GW	JCK117	VOC	LOW	A	GSC SOP	GW PLUME
JCK140		GW	JCK140	VOC MNA Parameters	LOW	Q *	GSC SOP	MNA
OTN007		GW	OTN007	VOC MNA Parameters	LOW	Q *	GSC SOP	MNA
SEY005	Shallow	GW	SEY005-S	VOC MNA Parameters	LOW	Q *	GSC SOP	MNA
	Deep	GW	SEY005-D	VOC MNA Parameters	LOW	Q *	GSC SOP	MNA
SEY006		GW	SEY006	VOC MNA Parameters	LOW	Q *	GSC SOP	MNA
SEY007	Shallow	GW	SEY007-S	VOC	LOW	A	GSC SOP	GW PLUME
	Deep	GW	SEY007-D	VOC MNA Parameters	LOW	A *	GSC SOP	MNA
SHN472		GW	SHN472	VOC MNA Parameters	LOW	Q *	GSC SOP	MNA
SHN478	Shallow	GW	SHN478-S	VOC	LOW	Q	GSC SOP	GW PLUME
	Deep	GW	SHN478-D	VOC	LOW	A	GSC SOP	GW PLUME
SHN499	Shallow	GW	SHN499-S	VOC MNA Parameters	LOW	Q *	GSC SOP	MNA

Monitoring Years 1 -5

Sampling Location/ID Number		Matrix[1]	Location ID	Analytical Group(s)	Concentration Level	Sampling Frequency per Year[2]	Sampling SOP Reference[3]	Rationale for Sampling Location[4]
	Deep	GW	SHN499-D	VOC MNA Parameters	LOW	S *	GSC SOP	MNA
SHN589		GW	SHN589	VOC MNA Parameters	LOW	Q *	GSC SOP	MNA
SHN603		GW	SHN603	VOC MNA Parameters	LOW	Q *	GSC SOP	MNA
STN051	Shallow	GW	STN051-S	VOC MNA Parameters	LOW	S *	GSC SOP	SETS, MNA
	Deep	GW	STN051-D	VOC MNA Parameters	LOW	Q *	GSC SOP	SETS, MNA
TWN134	300 ft	GW	TWN134	VOC	LOW	Q	GSC SOP	GW PLUME
Source Extraction Wells (Collected Concurrently with SETS SPDES Monitoring)								
SRMW-18RA		GW	SR18A	VOC	LOW	M	GSC SOP	SETS
SRMW-18RB		GW	SR18B	VOC	LOW	M	GSC SOP	SETS
SRMW-18RC		GW	SR18C	VOC	LOW	M	GSC SOP	SETS
SRMW-18RE		GW	SR18E	VOC	LOW	M	GSC SOP	SETS
Shallow Facility Groundwater (Pit Water Samples)								
Large Pit Water Collection Pipe		GW	SUMP A, B, C	VOC	LOW	Q	GSC SOP	SETS
Northern Water Collection Pipe		GW	SUMP D	VOC	LOW	Q	GSC SOP	SETS
Central Water Collection Pipe		GW	SUMP E	VOC	LOW	Q	GSC SOP	SETS
Southern Water Collection Pipe		GW	SUMP F	VOC	LOW	Q	GSC SOP	SETS
Groundwater Seep								
SRSP-03		GW	SRSP03	VOC	LOW	Q	GSC SOP	GW PLUME

Monitoring Years 1 -5								
Sampling Location/ID Number		**Matrix[1]**	**Location ID**	**Analytical Group(s)**	**Concentration Level**	**Sampling Frequency per Year[2]**	**Sampling SOP Reference[3]**	**Rationale for Sampling Location[4]**
Surface Water								
SRSW-12		SW	SRSW12	VOC	LOW	Q	GSC SOP	SW
SRSW-13		SW	SRSW13	VOC	LOW	Q	GSC SOP	SW
SRSW-14		SW	SRSW14	VOC	LOW	Q	GSC SOP	SW
SRSW-18		SW	SRSW18	VOC	LOW	Q	GSC SOP	SW
Sediments								
SRSD-12		Sediment	SRSD12	VOC	LOW	Q	GSC SOP	SEDIMENTS
SRSD-13		Sediment	SRSD13	VOC	LOW	Q	GSC SOP	SEDIMENTS
SRSD-14		Sediment	SRSD14	VOC	LOW	Q	GSC SOP	SEDIMENTS
SRSD-18		Sediment	SRSD18	VOC	LOW	Q	GSC SOP	SEDIMENTS

[1] GW=Groundwater; SW=Surface Water

[2] A=Annual; S=Semiannual; Q=Quarterly; M=Monthly

[3] Refer to the Analytical SOP References table (Worksheet #21)

[4] Refer to Worksheet #17 for description of rationale for sampling locations

QAPP Worksheet #18-2: Sampling Locations and Methods/SOP Requirements (Years 6-15)

Monitoring Years 6 -15								
Sampling Location/ID Number		**Matrix[1]**	**Location ID**	**Analytical Group(s)**	**Concentration Level**	**Sampling Frequency per Year[2]**	**Sampling SOP Reference[3]**	**Rationale for Sampling Location[4]**
Groundwater Monitoring								
SRMW-1RC		GW	S01C030	VOC MNA Parameters	LOW	A*	GSC SOP	SETS, MNA
SRMW-2RA		GW	S02A240	VOC MNA Parameters	LOW	A*	GSC SOP	SETS
SRMW-11R	Port 4	GW	S11R315	VOC MNA Parameters	LOW	A*	GSC SOP	MNA
SRMW-12S		GW	S12S019	VOC MNA Parameters	LOW	S*	GSC SOP	MNA
SRMW-12RA		GW	S12RA250	VOC MNA Parameters	LOW	S*	GSC SOP	MNA
SRMW-12RB		GW	S12RB118	VOC MNA Parameters	LOW	A*	GSC SOP	MNA
SRMW-12RC		GW	S12RC270	VOC	LOW	A	GSC SOP	GW PLUME
SRMW-14S		GW	S14S027	VOC MNA Parameters	LOW	S*	GSC SOP	MNA
SRMW-14R	Port 1	GW	S14R150	VOC MNA Parameters	LOW	A*	GSC SOP	MNA
	Port 2	GW	S14R364	VOC	LOW	A	GSC SOP	SETS
SRMW-14RA		GW	S14A120	VOC MNA Parameters	LOW	A*	GSC SOP	MNA
SRMW-14RB		GW	S14B090	VOC MNA Parameters	LOW	S*	GSC SOP	MNA
SRMW-15R	Port 2	GW	S15R197	VOC MNA Parameters	LOW	A*	GSC SOP	MNA
	Port 3	GW	S15R320	VOC MNA Parameters	LOW	A*	GSC SOP	MNA
	Port 4	GW	S15R340	VOC MNA Parameters	LOW	S*	GSC SOP	MNA
SRMW-16R	Port 1	GW	S16R038	VOC	LOW	A	GSC SOP	GW PLUME

Monitoring Years 6 -15

Sampling Location/ID Number		Matrix[1]	Location ID	Analytical Group(s)	Concentration Level	Sampling Frequency per Year[2]	Sampling SOP Reference[3]	Rationale for Sampling Location[4]
	Port 2	GW	S16R130	VOC	LOW	A	GSC SOP	GW PLUME
	Port 3	GW	S16R300	VOC MNA Parameters	LOW	S*	GSC SOP	MNA
SRMW-17R	Port 2	GW	S17R087	VOC	LOW	A	GSC SOP	SETS
	Port 3	GW	S17R139	VOC MNA Parameters	LOW	A*	GSC SOP	SETS, MNA
	Port 4	GW	S17R163	VOC	LOW	S	GSC SOP	SETS
	Port 5	GW	S17R230	VOC MNA Parameters	LOW	A*	GSC SOP	SETS, MNA
	Port 6	GW	S17R312	VOC	LOW	A	GSC SOP	SETS
	Port 7	GW	S17R413	VOC MNA Parameters	LOW	S*	GSC SOP	SETS, MNA
SRMW-18RD		GW	S18D247	VOC MNA Parameters	LOW	S*	GSC SOP	SETS, MNA
SRMW-18RF	Port 1	GW	S18F420	VOC MNA Parameters	LOW	A*	GSC SOP	SETS, MNA
BRB003		GW	BRB003	VOC MNA Parameters	LOW	S*	GSC SOP	SETS, MNA
BRB005	Shallow	GW	BRB005-S	VOC MNA Parameters	LOW	A*	GSC SOP	SETS, MNA
	Deep	GW	BRB005-D	VOC MNA Parameters	LOW	S*	GSC SOP	SETS, MNA
BRB006	Shallow	GW	BRB006-S	VOC MNA Parameters	LOW	A*	GSC SOP	SETS, MNA
	Deep	GW	BRB006-D	VOC MNA Parameters	LOW	S*	GSC SOP	SETS, MNA
BRB007	Shallow	GW	BRB007-S	VOC	LOW	A	GSC SOP	SETS, MNA
	Deep	GW	BRB007-D	VOC	LOW	S	GSC SOP	SETS, MNA
BRB009	Shallow	GW	BRB009-S	VOC	LOW	A	GSC SOP	SETS
	Deep	GW	BRB009-D	VOC MNA Parameters	LOW	S*	GSC SOP	SETS, MNA

Monitoring Years 6 -15

Sampling Location/ID Number		Matrix[1]	Location ID	Analytical Group(s)	Concentration Level	Sampling Frequency per Year[2]	Sampling SOP Reference[3]	Rationale for Sampling Location[4]
BRB011	Shallow	GW	BRB011-S	VOC	LOW	A	GSC SOP	SETS
	Deep	GW	BRB011-D	VOC MNA Parameters	LOW	S*	GSC SOP	SETS, MNA
EHC002	Deep	GW	EHC002-D	VOC MNA Parameters	LOW	A*	GSC SOP	SETS, MNA
EHC009		GW	EHC009	VOC	LOW	A	GSC SOP	SETS
EHC017		GW	EHC017	VOC	LOW	A	GSC SOP	SETS
GRF006		GW	GRF006	VOC	LOW	A	GSC SOP	GW PLUME
GRF007		GW	GRF007	VOC	LOW	A	GSC SOP	GW PLUME
JCK117		GW	JCK117	VOC	LOW	A	GSC SOP	GW PLUME
JCK140		GW	JCK140	VOC MNA Parameters	LOW	S*	GSC SOP	MNA
OTN007		GW	OTN007	VOC MNA Parameters	LOW	S*	GSC SOP	MNA
SEY005	Shallow	GW	SEY005-S	VOC MNA Parameters	LOW	S*	GSC SOP	MNA
	Deep	GW	SEY005-D	VOC MNA Parameters	LOW	S*	GSC SOP	MNA
SEY006		GW	SEY006	VOC MNA Parameters	LOW	S*	GSC SOP	MNA
SEY007	Shallow	GW	SEY007-S	VOC	LOW	A	GSC SOP	GW PLUME
	Deep	GW	SEY007-D	VOC MNA Parameters	LOW	A*	GSC SOP	MNA
SHN472		GW	SHN472	VOC MNA Parameters	LOW	S*	GSC SOP	MNA
SHN478	Shallow	GW	SHN478-S	VOC	LOW	S	GSC SOP	GW PLUME
	Deep	GW	SHN478-D	VOC	LOW	A	GSC SOP	GW PLUME
SHN499	Shallow	GW	SHN499-S	VOC MNA Parameters	LOW	S*	GSC SOP	MNA

Monitoring Years 6 -15

Sampling Location/ID Number		Matrix[1]	Location ID	Analytical Group(s)	Concentration Level	Sampling Frequency per Year[2]	Sampling SOP Reference[3]	Rationale for Sampling Location[4]
	Deep	GW	SHN499-D	VOC MNA Parameters	LOW	A *	GSC SOP	MNA
SHN589		GW	SHN589	VOC MNA Parameters	LOW	S *	GSC SOP	MNA
SHN603		GW	SHN603	VOC MNA Parameters	LOW	S *	GSC SOP	MNA
STN051	Shallow	GW	STN051-S	VOC MNA Parameters	LOW	A *	GSC SOP	SETS, MNA
	Deep	GW	STN051-D	VOC MNA Parameters	LOW	S *	GSC SOP	SETS, MNA
TWN134	300 ft	GW	TWN134	VOC	LOW	S	GSC SOP	GW PLUME
Source Extraction Wells (Collected Concurrently with SETS SPDES Monitoring)								
SRMW-18RA		GW	SR18A	VOC	LOW	M	GSC SOP	SETS
SRMW-18RB		GW	SR18B	VOC	LOW	M	GSC SOP	SETS
SRMW-18RC		GW	SR18C	VOC	LOW	M	GSC SOP	SETS
SRMW-18RE		GW	SR18E	VOC	LOW	M	GSC SOP	SETS
Shallow Facility Groundwater (Pit Water Samples)								
Large Pit Water Collection Pipe		GW	SUMP A, B, C	VOC	LOW	S	GSC SOP	SETS
Northern Water Collection Pipe		GW	SUMP D	VOC	LOW	S	GSC SOP	SETS
Central Water Collection Pipe		GW	SUMP E	VOC	LOW	S	GSC SOP	SETS
Southern Water Collection Pipe		GW	SUMP F	VOC	LOW	S	GSC SOP	SETS
Groundwater Seep								
SRSP-03		GW	SRSP03	VOC	LOW	S	GSC SOP	GW PLUME

Monitoring Years 6 -15

Sampling Location/ID Number		Matrix[1]	Location ID	Analytical Group(s)	Concentration Level	Sampling Frequency per Year[2]	Sampling SOP Reference[3]	Rationale for Sampling Location[4]
Surface Water								
SRSW-12		SW	SRSW12	VOC	LOW	S	GSC SOP	SW
SRSW-13		SW	SRSW13	VOC	LOW	S	GSC SOP	SW
SRSW-14		SW	SRSW14	VOC	LOW	S	GSC SOP	SW
SRSW-18		SW	SRSW18	VOC	LOW	S	GSC SOP	SW
Sediments								
SRSD-12		Sediment	SRSD12	VOC	LOW	S	GSC SOP	SEDIMENTS
SRSD-13		Sediment	SRSD13	VOC	LOW	S	GSC SOP	SEDIMENTS
SRSD-14		Sediment	SRSD14	VOC	LOW	S	GSC SOP	SEDIMENTS
SRSD-18		Sediment	SRSD18	VOC	LOW	S	GSC SOP	SEDIMENTS

[1] GW=Groundwater; SW=Surface Water
[2] A=Annual; S=Semiannual; Q=Quarterly; M=Monthly
[3] Refer to the Analytical SOP References table (Worksheet #21)
[4] Refer to Worksheet #17 for description of rationale for sampling locations

QAPP Worksheet #18-3: Sampling Locations and Methods/SOP Requirements (Years 16-18)

Monitoring Years 16 -18								
Sampling Location/ID Number		**Matrix[1]**	**Location ID**	**Analytical Group(s)**	**Concentration Level**	**Sampling Frequency per Year[2]**	**Sampling SOP Reference[3]**	**Rationale for Sampling Location[4]**
Groundwater Monitoring								
SRMW-1RC		GW	S01C030	VOC MNA Parameters	LOW	A *	GSC SOP	SETS, MNA
SRMW-2RA		GW	S02A240	VOC MNA Parameters	LOW	A *	GSC SOP	SETS
SRMW-11R	Port 4	GW	S11R315	VOC MNA Parameters	LOW	A *	GSC SOP	MNA
SRMW-12S		GW	S12S019	VOC MNA Parameters	LOW	Q *	GSC SOP	MNA
SRMW-12RA		GW	S12RA250	VOC MNA Parameters	LOW	Q *	GSC SOP	MNA
SRMW-12RB		GW	S12RB118	VOC MNA Parameters	LOW	A *	GSC SOP	MNA
SRMW-12RC		GW	S12RC270	VOC	LOW	A	GSC SOP	GW PLUME
SRMW-14S		GW	S14S027	VOC MNA Parameters	LOW	Q *	GSC SOP	MNA
SRMW-14R	Port 1	GW	S14R150	VOC MNA Parameters	LOW	A *	GSC SOP	MNA
	Port 2	GW	S14R364	VOC	LOW	A	GSC SOP	SETS
SRMW-14RA		GW	S14A120	VOC MNA Parameters	LOW	A *	GSC SOP	MNA
SRMW-14RB		GW	S14B090	VOC MNA Parameters	LOW	Q *	GSC SOP	MNA
SRMW-15R	Port 2	GW	S15R197	VOC MNA Parameters	LOW	A *	GSC SOP	MNA
	Port 3	GW	S15R320	VOC MNA Parameters	LOW	A *	GSC SOP	MNA
	Port 4	GW	S15R340	VOC MNA Parameters	LOW	Q *	GSC SOP	MNA
SRMW-16R	Port 1	GW	S16R038	VOC	LOW	A	GSC SOP	GW PLUME

Monitoring Years 16 -18

Sampling Location/ID Number		Matrix[1]	Location ID	Analytical Group(s)	Concentration Level	Sampling Frequency per Year[2]	Sampling SOP Reference[3]	Rationale for Sampling Location[4]
	Port 2	GW	S16R130	VOC	LOW	A	GSC SOP	GW PLUME
	Port 3	GW	S16R300	VOC MNA Parameters	LOW	Q *	GSC SOP	MNA
SRMW-17R	Port 2	GW	S17R087	VOC	LOW	A	GSC SOP	SETS
	Port 3	GW	S17R139	VOC MNA Parameters	LOW	A *	GSC SOP	SETS, MNA
	Port 4	GW	S17R163	VOC	LOW	Q	GSC SOP	SETS
	Port 5	GW	S17R230	VOC MNA Parameters	LOW	A *	GSC SOP	SETS, MNA
	Port 6	GW	S17R312	VOC	LOW	A	GSC SOP	SETS
	Port 7	GW	S17R413	VOC MNA Parameters	LOW	Q *	GSC SOP	SETS, MNA
SRMW-18RD		GW	S18D247	VOC MNA Parameters	LOW	Q *	GSC SOP	SETS, MNA
SRMW-18RF	Port 1	GW	S18F420	VOC MNA Parameters	LOW	A *	GSC SOP	SETS, MNA
BRB003		GW	BRB003	VOC MNA Parameters	LOW	Q *	GSC SOP	SETS, MNA
BRB005	Shallow	GW	BRB005-S	VOC MNA Parameters	LOW	A *	GSC SOP	SETS, MNA
	Deep	GW	BRB005-D	VOC MNA Parameters	LOW	Q *	GSC SOP	SETS, MNA
BRB006	Shallow	GW	BRB006-S	VOC MNA Parameters	LOW	A *	GSC SOP	SETS, MNA
	Deep	GW	BRB006-D	VOC MNA Parameters	LOW	Q *	GSC SOP	SETS, MNA
BRB007	Shallow	GW	BRB007-S	VOC	LOW	A	GSC SOP	SETS, MNA
	Deep	GW	BRB007-D	VOC	LOW	Q	GSC SOP	SETS, MNA
BRB009	Shallow	GW	BRB009-S	VOC	LOW	A	GSC SOP	SETS
	Deep	GW	BRB009-D	VOC MNA Parameters	LOW	Q *	GSC SOP	SETS, MNA

Monitoring Years 16 -18

Sampling Location/ID Number		Matrix[1]	Location ID	Analytical Group(s)	Concentration Level	Sampling Frequency per Year[2]	Sampling SOP Reference[3]	Rationale for Sampling Location[4]
BRB011	Shallow	GW	BRB011-S	VOC	LOW	A	GSC SOP	SETS
	Deep	GW	BRB011-D	VOC MNA Parameters	LOW	Q*	GSC SOP	SETS, MNA
EHC002	Deep	GW	EHC002-D	VOC MNA Parameters	LOW	A*	GSC SOP	SETS, MNA
EHC009		GW	EHC009	VOC	LOW	A	GSC SOP	SETS
EHC017		GW	EHC017	VOC	LOW	A	GSC SOP	SETS
GRF006		GW	GRF006	VOC	LOW	A	GSC SOP	GW PLUME
GRF007		GW	GRF007	VOC	LOW	A	GSC SOP	GW PLUME
JCK117		GW	JCK117	VOC	LOW	A	GSC SOP	GW PLUME
JCK140		GW	JCK140	VOC MNA Parameters	LOW	Q*	GSC SOP	MNA
OTN007		GW	OTN007	VOC MNA Parameters	LOW	Q*	GSC SOP	MNA
SEY005	Shallow	GW	SEY005-S	VOC MNA Parameters	LOW	Q*	GSC SOP	MNA
	Deep	GW	SEY005-D	VOC MNA Parameters	LOW	Q*	GSC SOP	MNA
SEY006		GW	SEY006	VOC MNA Parameters	LOW	Q*	GSC SOP	MNA
SEY007	Shallow	GW	SEY007-S	VOC	LOW	A	GSC SOP	GW PLUME
	Deep	GW	SEY007-D	VOC MNA Parameters	LOW	A*	GSC SOP	MNA
SHN472		GW	SHN472	VOC MNA Parameters	LOW	Q*	GSC SOP	MNA
SHN478	Shallow	GW	SHN478-S	VOC	LOW	Q	GSC SOP	GW PLUME
	Deep	GW	SHN478-D	VOC	LOW	A	GSC SOP	GW PLUME
SHN499	Shallow	GW	SHN499-S	VOC MNA Parameters	LOW	Q*	GSC SOP	MNA

Monitoring Years 16 -18

Sampling Location/ID Number		Matrix[1]	Location ID	Analytical Group(s)	Concentration Level	Sampling Frequency per Year[2]	Sampling SOP Reference[3]	Rationale for Sampling Location[4]
	Deep	GW	SHN499-D	VOC MNA Parameters	LOW	A *	GSC SOP	MNA
SHN589		GW	SHN589	VOC MNA Parameters	LOW	Q *	GSC SOP	MNA
SHN603		GW	SHN603	VOC MNA Parameters	LOW	Q *	GSC SOP	MNA
STN051	Shallow	GW	STN051-S	VOC MNA Parameters	LOW	A *	GSC SOP	SETS, MNA
	Deep	GW	STN051-D	VOC MNA Parameter	LOW	Q *	GSC SOP	SETS, MNA
TWN134	300 ft	GW	TWN134	VOC	LOW	Q	GSC SOP	GW PLUME
Source Extraction Wells (Collected Concurrently with SETS SPDES Monitoring)								
SRMW-18RA		GW	SR18A	VOC	LOW	Q	GSC SOP	SETS
SRMW-18RB		GW	SR18B	VOC	LOW	Q	GSC SOP	SETS
SRMW-18RC		GW	SR18C	VOC	LOW	Q	GSC SOP	SETS
SRMW-18RE		GW	SR18E	VOC	LOW	Q	GSC SOP	SETS
Shallow Facility Groundwater (Pit Water Samples)								
Large Pit Water Collection Pipe		GW	SUMP A, B, C	VOC	LOW	Q	GSC SOP	SETS
Northern Water Collection Pipe		GW	SUMP D	VOC	LOW	Q	GSC SOP	SETS
Central Water Collection Pipe		GW	SUMP E	VOC	LOW	Q	GSC SOP	SETS
Southern Water Collection Pipe		GW	SUMP F	VOC	LOW	Q	GSC SOP	SETS
Groundwater Seep								
SRSP-03		GW	SRSP03	VOC	LOW	Q	GSC SOP	GW PLUME

Monitoring Years 16 -18

Sampling Location/ID Number		**Matrix[1]**	**Location ID**	**Analytical Group(s)**	**Concentration Level**	**Sampling Frequency per Year[2]**	**Sampling SOP Reference[3]**	**Rationale for Sampling Location[4]**
Surface Water								
SRSW-12		SW	SRSW12	VOC	LOW	Q	GSC SOP	SW
SRSW-13		SW	SRSW13	VOC	LOW	Q	GSC SOP	SW
SRSW-14		SW	SRSW14	VOC	LOW	Q	GSC SOP	SW
SRSW-18		SW	SRSW18	VOC	LOW	Q	GSC SOP	SW
Sediments								
SRSD-12		Sediment	SRSD12	VOC	LOW	Q	GSC SOP	SEDIMENTS
SRSD-13		Sediment	SRSD13	VOC	LOW	Q	GSC SOP	SEDIMENTS
SRSD-14		Sediment	SRSD14	VOC	LOW	Q	GSC SOP	SEDIMENTS
SRSD-18		Sediment	SRSD18	VOC	LOW	Q	GSC SOP	SEDIMENTS

[1] GW=Groundwater; SW=Surface Water

[2] A=Annual; S=Semiannual; Q=Quarterly; M=Monthly

[3] Refer to the Analytical SOP References table (Worksheet #21)

[4] Refer to Worksheet #17 for description of rationale for sampling locations

QAPP Worksheet #18-4: Sampling Locations and Methods/SOP Requirements (Years 19-30)

Monitoring Years 19 - 30

Sampling Location/ID Number		**Matrix[1]**	**Location ID**	**Analytical Group(s)**	**Concentration Level**	**Sampling Frequency per Year[2]**	**Sampling SOP Reference[3]**	**Rationale for Sampling Location[4]**
Groundwater Monitoring								
SRMW-1RC		GW						
SRMW-2RA		GW						
SRMW-11R	Port 4	GW						
SRMW-12S		GW	S12S019	VOC MNA Parameters	LOW	S *	GSC SOP	MNA
SRMW-12RA		GW	S12RA250	VOC MNA Parameters	LOW	S *	GSC SOP	MNA
SRMW-12RB		GW						
SRMW-12RC		GW						
SRMW-14S		GW	S14S027	VOC MNA Parameters	LOW	S *	GSC SOP	MNA
SRMW-14R	Port 1	GW						
	Port 2	GW						
SRMW-14RA		GW						
SRMW-14RB		GW	S14B090	VOC MNA Parameters	LOW	S *	GSC SOP	MNA
SRMW-15R	Port 2	GW						
	Port 3	GW						
	Port 4	GW						
SRMW-16R	Port 1	GW						
	Port 2	GW						

Monitoring Years 19 - 30

Sampling Location/ID Number		**Matrix[1]**	**Location** ID	**Analytical Group(s)**	**Concentration Level**	**Sampling Frequency per Year[2]**	**Sampling SOP Reference[3]**	**Rationale for Sampling Location[4]**
	Port 3	GW						
SRMW-17R	Port 2	GW						
	Port 3	GW						
	Port 4	GW						
	Port 5	GW						
	Port 6	GW						
	Port 7	GW						
SRMW-18RD		GW						
SRMW-18RF	Port 1	GW						
BRB003		GW						
BRB005	Shallow	GW						
	Deep	GW						
BRB006	Shallow	GW						
	Deep	GW						
BRB007	Shallow	GW						
	Deep	GW						
BRB009	Shallow	GW						
	Deep	GW						
BRB011	Shallow	GW						
	Deep	GW						

Monitoring Years 19 - 30

Sampling Location/ID Number		Matrix[1]	Location ID	Analytical Group(s)	Concentration Level	Sampling Frequency per Year[2]	Sampling SOP Reference[3]	Rationale for Sampling Location[4]
EHC002	Deep	GW						
EHC009		GW						
EHC017		GW						
GRF006		GW						
GRF007		GW						
JCK117		GW						
JCK140		GW						
OTN007		GW						
SEY005	Shallow	GW						
	Deep	GW						
SEY006		GW						
SEY007	Shallow	GW						
	Deep	GW						
SHN472		GW	SHN472	VOC MNA Parameters	LOW	S*	GSC SOP	MNA
SHN478	Shallow	GW	SHN478-S	VOC	LOW	S	GSC SOP	GW PLUME
	Deep	GW						
SHN499	Shallow	GW						
	Deep	GW						
SHN589		GW						
SHN603		GW						

Monitoring Years 19 - 30

Sampling Location/ID Number		Matrix[1]	Location ID	Analytical Group(s)	Concentration Level	Sampling Frequency per Year[2]	Sampling SOP Reference[3]	Rationale for Sampling Location[4]
STN051	Shallow	GW						
	Deep	GW						
TWN134	300 ft	GW						
Source Extraction Wells (Collected Concurrently with SETS SPDES Monitoring)								
SRMW-18RA		GW	SR18A	VOC	LOW	S	GSC SOP	SETS
SRMW-18RB		GW	SR18B	VOC	LOW	S	GSC SOP	SETS
SRMW-18RC		GW	SR18C	VOC	LOW	S	GSC SOP	SETS
SRMW-18RE		GW	SR18E	VOC	LOW	S	GSC SOP	SETS
Shallow Facility Groundwater (Pit Water Samples)								
Large Pit Water Collection Pipe		GW	SUMP A, B, C	VOC	LOW	S	GSC SOP	SETS
Northern Water Collection Pipe		GW	SUMP D	VOC	LOW	S	GSC SOP	SETS
Central Water Collection Pipe		GW	SUMP E	VOC	LOW	S	GSC SOP	SETS
Southern Water Collection Pipe		GW	SUMP F	VOC	LOW	S	GSC SOP	SETS
Groundwater Seep								
SRSP-03		GW	SPSP03	VOC	LOW	S	GSC SOP	GW PLUME
Surface Water								
SRSW-12		SW	SRSW12	VOC	LOW	S	GSC SOP	SW
SRSW-13		SW	SRSW13	VOC	LOW	S	GSC SOP	SW

Monitoring Years 19 - 30								
Sampling Location/ID Number		**Matrix[1]**	**Location ID**	**Analytical Group(s)**	**Concentration Level**	**Sampling Frequency per Year[2]**	**Sampling SOP Reference[3]**	**Rationale for Sampling Location[4]**
SRSW-14		SW	SRSW14	VOC	LOW	S	GSC SOP	SW
SRSW-18		SW	SRSW18	VOC	LOW	S	GSC SOP	SW
Sediments								
SRSD-12		Sediment	SRSD12	VOC	LOW	S	GSC SOP	SEDIMENTS
SRSD-13		Sediment	SRSD13	VOC	LOW	S	GSC SOP	SEDIMENTS
SRSD-14		Sediment	SRSD14	VOC	LOW	S	GSC SOP	SEDIMENTS
SRSD-18		Sediment	SRSD18	VOC	LOW	S	GSC SOP	SEDIMENTS

[1] GW=Groundwater; SW=Surface Water

[2] A=Annual; S=Semiannual; Q=Quarterly; M=Monthly

[3] Refer to the Analytical SOP References table (Worksheet #21)

[4] Refer to Worksheet #17 for description of rationale for sampling locations

QAPP Worksheet #19: Analytical SOP Requirements Table

Matrix	Analytical Group	Analytical and Preparation Method/ SOP Reference[1]	Containers (Number, Size, and Type)	Sample Volume	Preservation Requirements (Chemical, Temperature, Light Protected)	Maximum Holding Time (Preparation/Analysis)[2]
Water	Volatiles	Method 8260B BR-MV-006(A) BR-MV-007(P)	(3) 40 mL glass vials	120 mL	Cool 4±2°C pH < 2 with HCl	14 days to analysis
Water	Carbon Dioxide	Method RSK-175 BR-AT-006(A/P)	(3) 40 mL glass vials	120 mL	Cool 4±2°C	14 days to analysis
Water	Dissolved Gases	Method RSK-175 BR-AT-006(A/P)	(3) 40mL glass vials	120mL	Cool 4±2°C pH < 2 with HCl	14 days to analysis
Water	Metals	Method 6010A SOP-ICP-1 Method 6010C SOP-ICP-MS	(1) 500mL poly	500mL	Cool 4±2°C pH <2 with NO_3	6 months to analysis
Water	Total Dissolved Solids	SM 18-21 2540C SOP-TDS-1	(1) 250mL poly	250mL	Cool 4±2°C	7 days to analysis
Water	Nitrate (as Nitrogen)	EPA 600/R93-100 SOP-IC-1	(1) 250mL poly	250mL	Cool 4±2°C	48 hours to analysis
Water	Dissolved Oxygen	SM4500 CO SOP-OXD	(1) 300mL Glass Stopper	300mL	Cool 4±2°C HACH Manganous Sulfate Powder Pillow HACH Alkaline Iodide-Azide Reagent Powder Pillow	8 hours to analysis
Soils / Sediment	Volatiles	Method 8260B BR-MV-006(A) BR-MV-007(P)	(2) 40 mL glass vials	2 x 5 grams	To Lab: Cool 4±2°C At lab: Freeze -20 ± 10°C 5 mL of VOA Free water	48Hours to Freeze 14 days to analysis
			(1) 40 mL glass vial	1 x 5 grams	Cool 4±2°C 10 mL of Methanol	14 days to analysis
Soils / Sediment	Percent Moisture	BR-WC-006	(1) 4oz amber glass	10 grams	Cool 4±2°C	14 days to analysis
Solid / Sediment	Total Organic Carbon	Method Lloyd Kahn BR-WC-024	(1) 4oz amber glass	10 grams	Cool 4±2°C	14 days to analysis

[1] Complete reference provided in Analytical SOP References table Worksheet 23

[2] Maximum holding time is calculated from the time the sample is collected to the time the sample is prepared/extracted. (Not VTSR)

QAPP Worksheet #20-1: Field Quality Control Sample Summary Table (Years 1 - 5)

Matrix	Analytical Group	Concentration Level	Analytical and Preparation SOP Reference[1]	No. of Samples per Year	No. of Field Duplicate Pairs	No. of MS	No. of Trip Blanks	No. of Equip. Blanks	No. of PT Samples	Total No. of Samples to Lab per Year
YEARS 1 - 5										
GW	VOC	Low	BR-MV-007(P) BR-MV-006(A)	159	1 per 20	1 per 20	1 per 20	1 per 20	NA	191
	Dissolved Gases	Low	BR-AT-006	124	1 per 20	1 per 20	1 per 20	1 per 20	NA	152
	DO	NA	SM4500 CO SOP-OXD	124	1 per 20	1 per 20	NA	NA	NA	138
	Nitrate (as Nitrogen)	NA	EPA 600/R93-100 SOP-IC-1	124	1 per 20	1 per 20	NA	NA	NA	138
GW Seeps	VOC	Low	BR-MV-007(P) BR-MV-006(A)	4	1 per 20	1 per 20	1 per 20	1 per 20	NA	8
Pit Water Shallow Facility GW	VOC	Low	BR-MV-007(P) BR-MV-006(A)	16	1 per 20	1 per 20	1 per 20	1 per 20	NA	20
SW	VOC	Low	BR-MV-007(P) BR-MV-006(A)	16	1 per 20	1 per 20	1 per 20	1 per 20	NA	20
Sediment	VOC	Low	BR-MV-007(P) BR-MV-006(A)	32	NA	NA	NA	1 per 20	NA	34
	TOC	NA	BR-WC-024	32	NA	NA	NA	1 per 20	NA	34
	% Moisture	NA	BR-WC-006	32	NA	NA	NA	1 per 20	NA	34

Notes:
W=Groundwater,
SW=Surface Water
NA=Not Applicable

[1] Complete reference provided in Analytical SOP References table (Worksheet #23)

QAPP Worksheet #20-2: Field Quality Control Sample Summary Table (Years 6 - 15)

Matrix	Analytical Group	Concentration Level	Analytical and Preparation SOP Reference[1]	No. of Samples Per Year	No. of Field Duplicate Pairs	No. of MS	No. of Trip Blanks	No. of Equip. Blanks	No. of PT Samples	Total No. of Samples to Lab per Year
YEARS 6 - 15										
GW	VOC	Low	BR-MV-007(P) BR-MV-006(A)	86	1 per 20	1 per 20	1 per 20	1 per 20	NA	106
	Dissolved Gases	Low	BR-AT-006	63	1 per 20	1 per 20	1 per 20	1 per 20	NA	79
	DO	NA	SM4500 CO SOP-OXD	63	1 per 20	1 per 20	NA	NA	NA	71
	Nitrate (as Nitrogen)	NA	EPA 600/R93-100 SOP-IC-1	63	1 per 20	1 per 20	NA	NA	NA	71
GW Seeps	VOC	Low	BR-MV-007(P) BR-MV-006(A)	2	1 per 20	1 per 20	1 per 20	1 per 20	NA	6
Pit Water Shallow Facility GW	VOC	Low	BR-MV-007(P) BR-MV-006(A)	8	1 per 20	1 per 20	1 per 20	1 per 20	NA	12
SW	VOC	Low	BR-MV-007(P) BR-MV-006(A)	8	1 per 20	1 per 20	1 per 20	1 per 20	NA	12
Sediment	VOC	Low	BR-MV-007(P) BR-MV-006(A)	16	NA	NA	1 per 20	1 per 20	NA	18
	TOC	NA	BR-WC-024	16	NA	NA	NA	NA	NA	16
	% Moisture	NA	BR-WC-006	16	NA	NA	NA	NA	NA	16

Notes: W=Groundwater,
SW=Surface Water
NA=Not Applicable

[1] Complete reference provided in Analytical SOP References table (Worksheet #23)

QAPP Worksheet #20-3: Field Quality Control Sample Summary Table (Years 16 - 18)

Matrix	Analytical Group	Concentration Level	Analytical and Preparation SOP Reference[1]	No. of Samples Per Year	No. of Field Duplicate Pairs	No. of MS	No. of Trip Blanks	No. of Equip. Blanks	No. of PT Samples	Total No. of Samples to Lab Per Year
YEARS 16 - 18										
GW	VOC	Low	BR-MV-007(P) BR-MV-006(A)	141	1 per 20	1 per 20	1 per 20	1 per 20	NA	173
	Dissolved Gases	Low	BR-AT-006	109	1 per 20	1 per 20	1 per 20	1 per 20	NA	133
	DO	NA	SM4500 CO SOP-OXD	109	1 per 20	1 per 20	NA	NA	NA	121
	Nitrate (as Nitrogen)	NA	EPA 600/R93-100 SOP-IC-1	109	1 per 20	1 per 20	NA	NA	NA	121
GW Seeps	VOC	Low	BR-MV-007(P) BR-MV-006(A)	4	1 per 20	1 per 20	1 per 20	1 per 20	NA	8
Pit Water Shallow Facility GW	VOC	Low	BR-MV-007(P) BR-MV-006(A)	16	1 per 20	1 per 20	1 per 20	1 per 20	NA	20
SW	VOC	Low	BR-MV-007(P) BR-MV-006(A)	16	1 per 20	1 per 20	1 per 20	1 per 20	NA	20
Sediment	VOC	Low	BR-MV-007(P) BR-MV-006(A)	32	NA	NA	1 per 20	1 per 20	NA	36
	TOC	NA	BR-WC-024	32	NA	NA	NA	NA	NA	32
	% Moisture	NA	BR-WC-006	32	NA	NA	NA	NA	NA	32

Notes:
W=Groundwater,
SW=Surface Water
NA=Not Applicable

[1] Complete reference provided in Analytical SOP References table (Worksheet #23)

QAPP Worksheet #20-4: Field Quality Control Sample Summary Table (Years 19 - 30)

Matrix	Analytical Group	Concentration Level	Analytical and Preparation SOP Reference[1]	No. of Samples Per Year	No. of Field Duplicate Pairs	No. of MS	No. of Trip Blanks	No. of Equip. Blanks	No. of PT Samples	Total No. of Samples to Lab per Year
YEARS 19 - 30										
GW	VOC	Low	BR-MV-007(P) BR-MV-006(A)	12	1 per 20	1 per 20	1 per 20	1 per 20	NA	16
	Dissolved Gases	Low	BR-AT-006	10	1 per 20	1 per 20	1 per 20	1 per 20	NA	14
	DO	NA	SM4500 CO SOP-OXD	10	1 per 20	1 per 20	NA	NA	NA	12
	Nitrate (as Nitrogen)	NA	EPA 600/R93-100 SOP-IC-1	10	1 per 20	1 per 20	NA	NA	NA	12
GW Seeps	VOC	Low	BR-MV-007(P) BR-MV-006(A)	2	1 per 20	1 per 20	1 per 20	1 per 20	NA	6
Pit Water Shallow Facility GW	VOC	Low	BR-MV-007(P) BR-MV-006(A)	8	1 per 20	1 per 20	1 per 20	1 per 20	NA	12
SW	VOC	Low	BR-MV-007(P) BR-MV-006(A)	8	1 per 20	1 per 20	1 per 20	1 per 20	NA	12
Sediment	VOC	Low	BR-MV-007(P) BR-MV-006(A)	16	NA	NA	1 per 20	1 per 20	NA	18
	TOC	NA	BR-WC-024	16	NA	NA	NA	NA	NA	16
	% Moisture	NA	BR-WC-006	16	NA	NA	NA	NA	NA	16

Notes:
W=Groundwater,
SW=Surface Water
NA=Not Applicable

[1] Complete reference provided in Analytical SOP References table (Worksheet #23)

QAPP Worksheet #21: Project Sampling SOP References Table

Reference Number	Title, Revision Date and/or Number	Originating Organization	Equipment Type	Modified for Project Work? (Check if yes)	Comments
GSC SOP Section 5.0	Pre-Sampling Preparation and Tasks (General Field Sampling Guidelines)	GSC	General Sampling	No	NA
GSC SOP Section 8.0	Sample Documentation	GSC	General Sampling	No	NA
GSC SOP Section 11.0	Sample Storage, Preservation and Handling	GSC	General Sampling	No	NA
GSC SOP Section 10.0	Sample Packaging and Shipment	GSC	General Sampling	No	NA
GSC SOP Section 7.0	Quality Assurance/Quality Control Samples	GSC	General Sampling	No	NA
GSC SOP Section 2.0	Groundwater Sampling Protocol	GSC	Groundwater Sampling	No	NA
GSC SOP Section 3.0	Surface Water Sample Collection Methods	GSC	General Sampling	No	NA
GSC SOP Section 4.0	Sediments Sample Collection Method	GSC	Sediments Sampling	No	NA
GSC SOP Section 9.0	Chain of Custody Procedures	GSC	General Sampling	No	NA

QAPP Worksheet #22: Field Equipment Calibration, Maintenance, Testing, and Inspection Table

Field Equipment	Calibration Activity	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference[1]
pH, Temp, Conductivity, DO, ORP Meter	Calibration	Clean Probes	Turn on, wait for system ok	Visually inspect probes	Daily during sampling Activities	Auto-calibration within Manufacturer Specifications	Re-calibrate, replace probe or remove from Service	GSC Field Personnel	GSC SOP, Section 5
Turbidity Meter	Calibration	Clean sensor cell	Turn on	Visually inspect sensor cell	Daily during sampling Activities	Calibrate as per Manufacturer Specifications	Re-calibrate, or remove from Service	GSC Field Personnel	GSC SOP, Section 5

[1] Specify the appropriate reference letter or number from the Project Sampling SOP References table (Worksheet #21)

QAPP Worksheet #23: Analytical SOP References Table

Lab SOP Number	Title, Revision Date, and/or Number	Definitive or Screening Data	Matrix and Analytical Group	Instrument	Organization Performing Analysis	Modified for Project Work (Y/N)
BR-MV-006	Volatile Organic Compounds by GC/MS (SW-846 8260B) SOP No. BR-MV-006, Rev 8, 05/28/10	Definitive	Solid/Sediment Volatiles	GC/MS	TestAmerica-Burlington	N
BR-MV-006	Volatile Organic Compounds by GC/MS (SW-846 8260B) SOP No. BR-MV-006, Rev 8, 05/28/10	Definitive	Aqueous Volatiles	GC/MS	TestAmerica-Burlington	N
BR-MV-007	VOA Sample Preservation & Screen Analysis Procedure (SW-846 5030A, 5035 and 5035A) SOP No. BR-MV- 007, Rev 5, 12/05/08	Definitive	Solid/Sediment Volatiles	NA Preparation	TestAmerica-Burlington	N
BR-MV-007	VOA Sample Preservation & Screen Analysis Procedure (SW-846 5030A, 5035 and 5035A) SOP No. BR-MV- 007, Rev 5, 12/05/08	Definitive	Aqueous Volatiles	NA Preparation	TestAmerica-Burlington	N
BR-AT-006	Dissolved Gases in Groundwater (RSK-175) SOP No. BR-AT-006, Rev 11, 05/07/10	Definitive	Aqueous Dissolved Gases	GC/FID	TestAmerica-Burlington	N
BR-AT-006	Dissolved Gases in Groundwater (RSK-175)	Definitive	Aqueous Carbon Dioxide	GC/TCD	TestAmerica-Burlington	N
BR-WC-024	Total Organic Carbon (Lloyd Kahn)	Definitive	Solid / Sediment TOC	Elemental Analyzer	TestAmerica-Burlington	N
BR-WC-006	Percent Total Moisture Determination SOP No. BR-WC-006, Rev 7, 808/16/2012	Definitive	Solid/Sediment %Moisture	Balance	TestAmerica-Burlington	N
SOP-IC-1	Inorganics by Ion Chromotgraphy (EPA 600/R93-100) SOP No. SOP-IC-1, Rev 6, 09/18/2013	Definitive	Aqueous Inorganic Compounds	Ion Chromatograph	EnviroTest	N
SOP-ICP-1	Determination of Metals & Trace Elements by ICP-AES (EPA 200.7 and 6010C) SOP No. SOP-ICP-1, Rev 5, 01/31/2013	Definitive	Aqueous Metals	ICP-AES	EnviroTest	N
SOP-ICPMS	Determination of Metals & Trace Elements by ICP-MS (EPA 200.8 and 6020A) SOP No. SOP-ICPMS, Rev 3, 02/28/2013	Definitive	Aqueous Metals	ICP-MS	EnviroTest	N
SOP-OXD	Dissolved Oxygen (SM4500 CO) SOP No. SOP-OXD, Rev 5, 10/19/2012	Definitive	Aqueous Dissolved Oxygen	Titration with Calculation	EnviroTest	N
SOP-TDS	Total Dissolved Solids (SM 18-21 2540C) SOP No. SOP-TDS-1, Rev 6, 10/04/2012	Definitive	Aqueous Total Dissolved Solids	Balance	EnviroTest	N

QAPP Worksheet #24: Analytical Instrument Calibration Table

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA	SOP Reference[1]
GC/MS SW-846 8260B	Tune Standard	Prior to initial calibration and every 12 hours	See Laboratory SOP	Reanalyze, retune mass spectrometer; no samples may be analyzed without a valid tune.	Laboratory Analyst	BR-MV-006
GC/MS SW-846 8260B	Five-point calibration	Before sample analysis, when CCVs indicate calibration is no longer valid; after major instrument maintenance	Option 1: Mean relative standard deviation (RSD) for all analytes ≤ 20% Option2: Linear Regression: r > 0.995	Instrument maintenance, standard, inspection, recalibration	Laboratory Analyst	BR-MV-006
GC/MS SW-846 8260B	Initial Calibration Verification	Immediately after each initial calibration	%R ± 25% of true value	Correct problem and verify second source standard. If that fails repeat calibration.	Laboratory Analyst	BR-MV-006
GC/MS SW-846 8260B	Continuing Calibration Verification	Beginning of each 12-hour window after the tune standard	See Laboratory SOP	See Laboratory SOP	Laboratory Analyst	BR-MV-006
GC/FID RSK-175	Five-point calibration	Before sample analysis, when CCVs indicate calibration is no longer valid; after major instrument maintenance	Calibration Factor RSD < 30%	Instrument maintenance, standard, inspection, recalibration	Laboratory Analyst	BR-AT-006
GC/FID RSK-175	Initial Calibration Verification	Immediately after each initial calibration	%R ± 30%	Correct problem and verify second source standard. If that fails repeat calibration.	Laboratory Analyst	BR-AT-006
GC/FID RSK-175	Continuing Calibration Verification	Beginning of each 24-hour window	%D ± 30%	See Laboratory SOP	Laboratory Analyst	BR-AT-006
EA Lloyd Kahn	Initial Calibration	Following each column change and when CCV failure indicates calibration may no longer be valid.	correlation coefficient > 0.995	Standards check, re-calibration	Laboratory Analyst	BR-WC-024
EA Lloyd Kahn	Acetanilide	Every 20 drops and at the end of the analytical run	%R = 85-115	Re-prepare and reanalyze samples not bracketed by passing standard.	Laboratory Analyst	BR-WC-024

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA	SOP Reference[1]
EA Lloyd Kahn	Blank (paired with Acetanilide)	Following each Acetanilide	< LOQ	Re-prepare and reanalyze batch.	Laboratory Analyst	BR-WC-024
IC Nitrate	Initial Calibration	As needed, no more than 1/month	%Difference <10%	Halt analysis, recalibrate. If still out, re-make standards and recalibrate.	Laboratory Analyst	SOP-IC-1
IC Nitrate	Continuing Calibration Blank (CCB)	One per every 10 samples.	< Detection Limit	Reanalyze, if still out, clean system and begin analysis over at last passing CCB.	Laboratory Analyst	SOP-IC-1
IC Nitrate	Continuing Calibration Blank (CCV)	One per every 10 samples.	90-110%	Reanalyze, if still out recalibrate and reanalyze all samples not bracketed by passing CCV.	Laboratory Analyst	SOP-IC-1
ICP Metals	Initial Calibration	Once every 24 hours or each time the instrument is set up	R$\geq$ 0.995	Re-analyze standards; if still problematic, check stock standards and reagents	Laboratory Analyst	SOP-ICP-1
ICP Metals	Initial Calibration Verification (ICV) 2^{nD} Source	Analyze immediately following calibration. One per analytical sequence	Limits: 95-105% (200.7) 90-110% (6010C)	Re-analyze one time, if still falls outside the control limit the analysis must be terminated, the cause determined and the instrument must be re-calibrated.	Laboratory Analyst	SOP-ICP-1
ICP Metals	Initial Calibration Blank (ICB)	Analyze immediately after ICV. One per analytical sequence.	< CRDL	Re-analyze one time, if the ICB still contains concentrations > CRDL, the analysis must be terminated, the cause determined and the instrument must be re-calibrated.	Laboratory Analyst	SOP-ICP-1
ICP Metals	CRI Standard	Analyzed at the beginning and end of each analytical sequence	No limits (200.7). 70-130% (6010C).	Reanalyze samples<2Xs CRI	Laboratory Analyst	SOP-ICP-1
ICP Metals	Continuing Calibration Verification (CCV)	Every 10 samples	90-110%	If the percent recovery falls outside the acceptable limits. Re-analyze one time, if still falls outside the control limit the analysis must be terminated, the cause determined and the instrument must be re-calibrated. The samples	Laboratory Analyst	SOP-ICP-1

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA	SOP Reference¹
				bracketed by that CCV must be re-analyzed.		
ICP Metals	Continuing Calibration Blank (CCB)	Every 10 samples	< CRDL	Re-analyze one time, if the CCB still fails, the analysis must be terminated, the cause determined and the instrument must be re-calibrated. The samples bracketed by that CCB must be re-analyzed.	Laboratory Analyst	SOP-ICP-1
ICP Metals	ICSA (initial and final)	Analyzed at the beginning and end of each analytical sequence	Al, Ca, Fe and Mg 80 – 120% All other elements absolute value ≤CRDL, if CDRL is ≤ 10ug/l absolute value should be ≤ 2Xs CRDL	If the recovery falls outside the acceptable limits, the analysis must be terminated, the caused determined and the instrument re-calibrated.	Laboratory Analyst	SOP-ICP-1
ICP Metals	ICSAB (initial and final)	Analyzed at the beginning and end of each analytical sequence	80 – 120%	If the recovery falls outside the acceptable limits, elements that fail may not be reported. The analysis must be terminated, the caused determined and the instrument re-calibrated for those elements	Laboratory Analyst	SOP-ICP-1
ICP-MS Metals	Daily Performance Standard	Daily	See sec.9.6 of SOP-ICPMS	Perform instrument maintenance and rerun standard. See instrument manual.	Laboratory Analyst	SOP-ICPMS
ICP-MS Metals	Tuning	Daily	See sec. 9.7 of SOP-ICPMS	Re-optimize	Laboratory Analyst	SOP-ICPMS
ICP-MS Metals	Initial Calibration	Following tuning and prior to sample analysis [Minimum of blk, plus (3) non blk stds]	r = ≥ 0.998	Re-calibrate	Laboratory Analyst	SOP-ICPMS
ICP-MS Metals	ICV (Initial Calibration Verification)	Once at start of analytical run	90-110%	Recalibrate. Re-check ICV; if still unacceptable, investigate possible calibration std or ICV out of specification.	Laboratory Analyst	SOP-ICPMS

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA	SOP Reference[1]
ICP-MS Metals	ICB (Initial Calibration Blank)	Once at start of analytical run	< RL	Recalibrate. Re-check ICB; if still unacceptable, investigate possible contamination of reagents, Milli-Q water.	Laboratory Analyst	SOP-ICPMS
ICP-MS Metals	Reporting Limit Calibration Check Standard (CRI)	Daily, if not part of calibration curve (also at end for 6020A)	70-130% (6020A)	Recalibrate, re-analyze	Laboratory Analyst	SOP-ICPMS
ICP-MS Metals	ICSA/AB	Daily at beginning of analytical run for 6020A	80-120% (6020A)	No action required.	Laboratory Analyst	SOP-ICPMS
ICP-MS Metals	CCV (Continuing Calibration Verification)	Every 10 samples or fraction thereof	85-115% (200.8) 90-110% (6020A)	If unacceptable, re-analyze; if still out recalibrate. Sample values for blocks between acceptable CCVs may be reported; those that are not must be rerun.	Laboratory Analyst	SOP-ICPMS
ICP-MS Metals	CCB (Continuing Calibration Blank)	Every 10 samples or fraction thereof	< RL	If unacceptable, re-analyze; if still out recalibrate. Sample values for blocks between acceptable CCB may be reported; those that are not must also be rerun.	Laboratory Analyst	SOP-ICPMS

[1] See Analytical SOP References table (Worksheet #23)

QAPP Worksheet #25: Analytical Instrument and Equipment Maintenance, Testing, and Inspection Table

Instrument/ Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference
GC/MS (VOA)	Clean Injection Port and Liner, Change Septa, Cut 2-3 inches from GC Column, Fill Autosampler rinse vials, Clean Purge and Trap mount and purge vessel		Check Injection Port and GC columns, Check autosampler rinse vials, check purge and trap mount and purge vessel, check Purge Flow	As required	Passing calibration	Perform maintenance, check standards, recalibrate	Laboratory Analyst	BR-QAM SOP A-13

[1] See Analytical SOP References table (Worksheet #23)

QAPP Worksheet #26: Sample Handling System

SAMPLE COLLECTION, PACKAGING, AND SHIPMENT
Sample Collection (Personnel/Organization): GSC Field Personnel Sample
Packaging (Personnel/Organization): GSC Field Personnel Coordination of Shipment.
Shipment (Personnel/Organization): GSC Field Personnel
Type of Shipment/Carrier: GSC Field Personnel/Federal Express
SAMPLE RECEIPT AND ANALYSIS
Sample Receipt (Personnel/Organization): Sample Receiving Personnel at TA-Burlington and EnviroTest laboratories
Sample Custody and Storage (Personnel/Organization): Sample Receiving Personnel at TA-Burlington and EnviroTest laboratories
Sample Preparation (Personnel/Organization): TA-Burlington and EnviroTest Laboratory Personnel
Sample Determinative Analysis (Personnel/Organization) TA-Burlington and EnviroTest laboratories
SAMPLE ARCHIVING
Sample Receiving: Samples to be shipped 1 to 10 days after collection
Sample Extract/Digestate Storage (No. of days from extraction/digestion): As per analytical methods
Biological Sample Storage (No. of days from sample collection): N/A
SAMPLE DISPOSAL
Personnel/Organization: TA-Burlington and EnviroTest laboratories
Number of Days from Analysis: N/A

QAPP Worksheet #27: Sample Custody Requirements

Field Sample Custody Procedures (sample collection, packaging, shipment, and delivery to laboratory):

All COC records will be reviewed prior to shipment of samples in accordance with GSC SOP, Section 9, *Chain of Custody Procedures*.

Groundwater, groundwater seeps, pit water, surface water and sediment samples collected by GSC personnel will be shipped within two business days of sampling completion for following day delivery under COC to the receiving Laboratory for analysis in accordance with GSC SOP Section 10, *Sample Packaging and Shipment.* Procedures outlined in GSC SOP Section 8, *Sample Documentation*, Section 11, *Sample, Storage and Preservation* and Section 10, *Sample Packaging and Shipment* will be applied (refer to Worksheet #21). All samples will be delivered under chain of custody (COC) to TestAmerica Burlington and EnviroTest Laboratories.

Laboratory Sample Custody Procedures (receipt of samples, archiving, disposal):

A sample custodian at the contract laboratory will accept custody of the samples and inspect the samples for discrepancies and container integrity before forwarding the samples to the appropriate department for analysis. No samples will be archived at the laboratories.

Sample Identification Procedures:

Each sample will be identified with a unique identification number at the time of collection and a laboratory identification number will be assigned to each sample at receipt at the TestAmerica Burlington and EnviroTest Laboratories. The number will be listed on the label of every sample container collected at a given location. Procedures outlined in GSC SOP Section 8 will be applied (refer to Worksheet #21).

Chain-of-custody Procedures:

Chain-of-custody records will be generated for all samples submitted for analysis. Procedures outlined in GSC SOP Section 9 will be applied (refer to Worksheet #21).

QAPP Worksheet #28-1: QC Samples Table Volatile Organics

Matrix	Aqueous / Solid / Sediment
Analytical Group	Volatile Organics
Sampling SOP	GSC SOP Section 4.0
Analytical Method/ SOP Reference	SW846 8260B VOCs by GC/MS BR-MV-006
Analytical Organization	TestAmerica - Burlington

QC Sample	**Frequency or Number**	**Method/SOP QC Acceptance Limits**	**Corrective Action**	**Person(s) Responsible for Corrective Action**	**Data Quality Indicator (DQI)**	**Measurement Performance Criteria**
Method Blank	Once every 12 hours	< LOQ	Reanalyze Batch	TestAmerica Laboratory	Contamination	See worksheet 15 for lab CRQL
Surrogates	Each sample, standard, blank	See worksheet 15	Reanalyze sample	TestAmerica Laboratory	Accuracy/Bias	Per Laboratory SOP
Laboratory Control Sample	Once every 12 hours	Per Worksheet 15	Reanalyze Batch	TestAmerica Laboratory	Accuracy	Per Laboratory SOP
Matrix Spike/Matrix Spike Duplicates (MS/MSD)	Each group of field samples in an SDG or each SDG, whichever is most frequent	See worksheet 15	None if laboratory control sample passes	TestAmerica Laboratory	Accuracy/Bias and Precision	Per laboratory SOP
Internal Standard	Each sample, standard, Blank	Area between 50-100% of area of daily calibration internal standard area	Reanalyze Sample	TestAmerica Laboratory	Instrument Performance	Per Laboratory SOP
Method Detection Limits	Annual	Per Laboratory SOP	Reanalyze MDL	TestAmerica Laboratory	Sensitivity	Low enough to support CRQLs

QAPP Worksheet #28-2: QC Samples Table Dissolved Gases

Matrix	Aqueous
Analytical Group	Dissolved Gases
Sampling SOP	GSC SOP Section 2.0
Analytical Method/ SOP Reference	RSK-175 Dissolved Gases in Groundwater BR-AT-006
Analytical Organization	TestAmerica - Burlington

QC Sample	**Frequency / Number**	**Method / SOP QC Acceptance Limits**	**Corrective Action**	**Person(s) Responsible for Corrective Action**	**Data Quality Indicator (DQI)**	**Measurement Performance Criteria**
Method Blank	Once every 24 hours	< LOQ	Reanalyze Batch	TestAmerica Laboratory	Contamination	See worksheet 15 for lab CRQL
Laboratory Control Sample	Once every 24 hours	%R = 70 - 130	Reanalyze Batch	TestAmerica Laboratory	Accuracy	Per Laboratory SOP
Matrix Spike/Matrix Spike Duplicates (MS/MSD)	Per client request	%R = 70 - 130	None if laboratory control sample passes	TestAmerica Laboratory	Accuracy/Bias and Precision	Per laboratory SOP
Sample Duplicate	Per client request	RPD < 30%	None if laboratory control sample passes	TestAmerica Laboratory	Precision	Per laboratory SOP
Method Detection Limits	Annual	Per Laboratory SOP	Reanalyze MDL	TestAmerica Laboratory	Sensitivity	Low enough to support CRQLs

QAPP Worksheet #28-3: QC Samples Table Carbon Dioxide

Matrix	Aqueous					
Analytical Group	Carbon Dioxide					
Sampling SOP	GSC SOP Section 2.0					
Analytical Method/ SOP Reference	RSK-175 Dissolved Gases in Groundwater BR-AT-006					
Analytical Organization	TestAmerica - Burlington					
QC Sample	**Frequency / Number**	**Method / SOP QC Acceptance Limits**	**Corrective Action**	**Person(s) Responsible for Corrective Action**	**Data Quality Indicator (DQI)**	**Measurement Performance Criteria**
Method Blank	Once every 24 hours	< LOQ	Reanalyze Batch	TestAmerica Laboratory	Contamination	See worksheet 15 for lab CRQL
Laboratory Control Sample	Once every 24 hours	%R = 70 - 130	Reanalyze Batch	TestAmerica Laboratory	Accuracy	Per Laboratory SOP
Matrix Spike/Matrix Spike Duplicates (MS/MSD)	Per client request	%R = 70 - 130	None if laboratory control sample passes	TestAmerica Laboratory	Accuracy/Bias and Precision	Per laboratory SOP
Sample Duplicate	Per client request	RPD < 30	None if laboratory control sample passes	TestAmerica Laboratory	Precision	Per laboratory SOP
Method Detection Limits	Annual	Per Laboratory SOP	Reanalyze MDL	TestAmerica Laboratory	Sensitivity	Low enough to support CRQLs

QAPP Worksheet #28-4: QC Samples Table Inorganics by Ion Chromatography

Matrix	Aqueous
Analytical Group	Inorganics by Ion Chromatography
Sampling SOP	GSC SOP Section 4.0
Analytical Method/ SOP Reference	SOP-IC-1
Analytical Organization	EnviroTest

QC Sample	**Frequency or Number**	**Method/SOP QC Acceptance Limits**	**Corrective Action**	**Person(s) Responsible for Corrective Action**	**Data Quality Indicator (DQI)**	**Measurement Performance Criteria**
Method Blank (CCB)	Once every 10 samples	< LOQ	Reanalyze Batch	EnviroTest Laboratories	Contamination	Per Laboratory SOP
Laboratory Control Sample	Once per matrix or per analytical batch	NO_3 90-110%	Reanalyze Batch	EnviroTest Laboratories	Accuracy	Per Laboratory SOP
Matrix Spike (MS)	One per analytical batch preferably on a sample with a positive result.	NO_3 90-110%	Reanalyze sample, if still out & LCS is within control limits, assume matrix interference.	EnviroTest Laboratories	Accuracy/Bias and Precision	Per laboratory SOP
Duplicate	One per matrix or per analytical batch	< 20% RPD	Reanalyze Sample, if precision not met determine if matrix or method is	EnviroTest Laboratories	Accuracy/Bias and Precision	Per Laboratory SOP
Method Detection Limits	Annual	Per Laboratory SOP	Reanalyze MDL	EnviroTest Laboratories	Sensitivity	Low enough to support CRQLs

QAPP Worksheet #28-5: QC Samples Table Metals by ICP-AES

Matrix	Aqueous / Solid / Sediment
Analytical Group	Metals
Sampling SOP	GSC SOP Section 4.0
Analytical Method/ SOP Reference	EPA 600/R93-100 Metals byICP-AES SOP-ICP-1
Analytical Organization	EnviroTest Laboratories

QC Sample	**Frequency or Number**	**Method/SOP QC Acceptance Limits**	**Corrective Action**	**Person(s) Responsible for Corrective Action**	**Data Quality Indicator (DQI)**	**Measurement Performance Criteria**
Method Blank	Once per digestion batch of 20 samples or less	< CRDL	Reanalyze Batch	EnviroTest Laboratories	Contamination	Per Laboratory SOP
Laboratory Control Sample	Once per digestion batch of 20 samples or less	85 - 115% (200.7) 80 - 120% (6010C)	If %R falls outside the acceptable limits the analysis must be terminated and associated samples re-digested and re-analyzed	EnviroTest Laboratories	Accuracy	Per Laboratory SOP
Matrix Spike (MS)	Once per digestion batch of 20 samples or less	70-130% (200.7) 75-125% (6010C) See Lab SOP	Sample is qualified. If LCS was within control limits, MS is matrix related	EnviroTest Laboratories	Accuracy/Bias and Precision	Per laboratory SOP
ICSA ICSAB	Analyzed at the beginning and end of each analytical sequence	80 – 120%	Analysis terminated Recalibrate instrument	EnviroTest Laboratories	Instrument Performance	Per Laboratory SOP
Method Detection Limits	Annual	Per Laboratory SOP	Reanalyze MDL	EnviroTest Laboratories	Sensitivity	Low enough to support CRQLs

QAPP Worksheet #28-6: QC Samples Table Metals by ICP-MS

Matrix	Aqueous / Solid / Sediment
Analytical Group	Metals
Sampling SOP	GSC SOP Section 4.0
Analytical Method/ SOP Reference	EPA 200.7 6010C Metals by ICP-MS SOP-ICPMS
Analytical Organization	EnviroTest Laboratories

QC Sample	Frequency or Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Method Blank	Once per digestion batch of 20 samples or less	< CRDL	Reanalyze Batch, Re-digest	EnviroTest Laboratories	Contamination	Per Laboratory SOP
Laboratory Control Sample (LCS)	Once per digestion batch of 20 samples or less	85 - 115% (200.8) 80 - 120% (6020A)	If %R falls outside the acceptable limits the analysis must be terminated and associated samples re-digested and re-analyzed	EnviroTest Laboratories	Accuracy	Per Laboratory SOP
Matrix Spike (MS)	Once per digestion batch of 20 samples or less	70-130% (200.8) 75-125% (6020A) See Lab SOP	Sample is qualified. If LCS was within control limits, MS is matrix related	EnviroTest Laboratories	Accuracy/Bias and Precision	Per laboratory SOP
ICSA ICSAB	Analyzed at the beginning and end of each analytical sequence	80 – 120%	See Laboratory SOP	EnviroTest Laboratories	Instrument Performance	Per Laboratory SOP
Method Detection Limits	Annual	Per Laboratory SOP	Reanalyze MDL	EnviroTest Laboratories	Sensitivity	Low enough to support CRQLs

QAPP Worksheet #28-7: QC Samples Table TOC

Matrix	Solid / Sediment
Analytical Group	TOC
Sampling SOP	GSC SOP Section 4.0
Analytical Method/ SOP Reference	Total Organic Carbon (Lloyd Kahn) BR-WC-024
Analytical Organization	TestAmerica - Burlington

QC Sample	**Frequency / Number**	**Method / SOP QC Acceptance Limits**	**Corrective Action**	**Person(s) Responsible for Corrective Action**	**Data Quality Indicator (DQI)**	**Measurement Performance Criteria**
Method Blank	Once per batch of 20 samples	< LOQ	Re-prepare and reanalyze batch.	TestAmerica Laboratory	Contamination	See worksheet 15 for lab LOQ
Laboratory Control Sample	Once per batch	%R = 75-125	Re-prepare and reanalyze batch.	TestAmerica Laboratory	Accuracy	Per Laboratory SOP
Matrix Spike (MS)	One per batch of 20 or less samples	%R = 75-125	None if laboratory control sample passes	TestAmerica Laboratory	Accuracy/Bias and Precision	Per laboratory SOP
Sample Replicate (REP)	One per batch of 20 or less samples	RPD ≤20	None if laboratory control sample passes	TestAmerica Laboratory	Accuracy/Bias and Precision	Per laboratory SOP
Sample precsion	Each sample is run in duplicate	RPD<40%	Analyze 2 more replicates and perform Dixon test for high and low outliers. Include Dixon spreadsheet in the data package and narrative note results.	TestAmerica Laboratory	Precision	Per laboratory SOP
Method Detection Limits	Annual	Per Laboratory SOP	Reanalyze MDL	TestAmerica Laboratory	Sensitivity	Low enough to support LOQs

QAPP Worksheet #29: Project Documents and Records Table

Sample Collection Documents and Records	On-site Analysis Documents and Records	Off-site Analysis Documents and Records	Data Assessment Documents and Records	Other
Site Maps Boring & Construction Logs Field Data Sheets Chain of Custody Records Sample Labels Custody Seals Maintenance Records Calibration Records	Daily observations and notes, personnel on-site, date and time Iterative measurements of pH, temperature, dissolved oxygen, turbidity and ORP Time/date of sampling, observations of water quality Sample numbers, number of containers, requested analyses, preservation Calibration Logs Equipment Maintenance forms	Chain-of-custody forms Sample Receipt, Sample Condition, Custody and Internal Tracking Records Laboratory Information Management System (LIMs) Login information Instrument run logs Standard traceability logs MDL/RL studies Laboratory Accreditation Certificates Quality Assurance Manual Analytical SOPs Instrument Calibration logs Non-conformance records QC Sample identification (blanks, replicates, duplicates, LCS, MS/MSD) Laboratory data qualifiers Preventive Maintenance logs Instrument printouts Data Reduction Records Data Review Records Analytical Results Case Narrative	Quality Assurance Manual Laboratory Accreditation Certificates EDDs PDFs of Final Laboratory Analytical Data Reports Data Assessment and Data Validation Reports Progress Reports Comprehensive 5-year Review	NA

QAPP Worksheet #30: Analytical Services Table

Matrix	Analytical Group	Sample Location / ID Numbers	Analytical and Preparation Method/ SOP Reference[1]	Data Package Turnaround Time	Laboratory/Organization (Name and Address, Contact Person and Telephone Number)	Backup Laboratory/ Organization (Name and Address, Contact Person and Telephone Number)
Water	Volatiles	See Worksheet #18	Method 8260B BR-MV-006(A), BR-MV-007(P)	20 days	Test America Burlington 30 Community Drive Suite 11 South Burlington, VT 05403 (802) 660-1990 PM: Kathryn Kelly	NA
Water	Carbon Dioxide	See Worksheet #18	Method RSK-175 BR-AT-006(A/P)	20 days		NA
Water	Dissolved Gases	See Worksheet #18	Method RSK-175 BR-AT-006(A/P)	20 days		NA
Soils / Sediment	Volatiles	See Worksheet #18	Method 8260B BR-MV-006(A) BR-MV-007(P)	20 days		NA
Solid / Sediment	Total Organic Carbon	See Worksheet #18	Method Lloyd Kahn BR-WC-024	20 days		NA
Water	Metals	See Worksheet #18	Method 6010A SOP-ICP-1 Method 6010C SOP-ICP-MS	20 days	EnvroTest Laboratories 315 Fullerton Avenue Newburgh, NY (845) 562-0890 PM: Doug Tawse	NA
Water	Nitrate	See Worksheet #18	EPA 600/R93-100 SOP-IC-1	20 days		NA
Water	Dissolved Oxygen	See Worksheet #18	SM4500 CO SOP-OXD	20 days		NA
Water	Total Dissolved Solids	See Worksheet #18	SM 18-21 2540C SOP-TDS-1	20 days		NA

[1] Complete reference provided in Analytical SOP References table Worksheet 23

QAPP Worksheet #31: Planned Project Assessments Table

Assessment Type	**Frequency**	**Internal or External**	**Organization Performing Assessment**	**Person(s) Responsible for Performing Assessment** (Title and Organizational Affiliation)	**Person(s) Responsible for Responding to Assessment Findings** (Title and Organizational Affiliation)	**Person(s) Responsible for Identifying and Implementing Corrective Actions (CA)** (title and Organizational Affiliation)	**Person(s) Responsible for Monitoring Effectiveness of CA** (Title and Organizational Affiliation)
Laboratory Accreditation Audit	Every 2 years	External	NELAC accrediting agency	NELAC accrediting agency	Laboratory Manager	Laboratory QA Manager	NELAC Accrediting Authority
Readiness Review	Prior to field activities	Internal	GSC	GSC PM GSC QAM	GSC FSM	GSC PM GSC FSM	GSC QAM
Field Sampling and COC Review against QAPP Requirements	Daily	Internal	GSC	GSC Scientist	GSC PM	GSC PM GSC FSM	GSC PM GSC FSM
Laboratory Report Deliverables & Analytical Results Against QAPP	Per Sample Delivery Group	External	Veridian	Veridian Chemist Veridian PM	Laboratory Director Laboratory PM	Laboratory Director Laboratory PM	GSC QAM
Data Validation	Per Sample Delivery Group	External	Veridian	Veridian Chemist Veridian PM	Laboratory QAM Laboratory PM	Laboratory QAM Laboratory PM	Veridian QAM Veridian PM
Field Sampling Technical Systems Audit (TSA)	Once per year	Internal	GSC	GSC PM GSC QAM	GSC FSM	GSC PM GSC FSM	GSC QAM
Data Review Technical Systems Audit (TSA)	Once per year	Internal	GSC	GSC QAM	Veridian QAM	Veridian PM	GSC QAM

QAPP Worksheet #32: Assessment Findings and Corrective Action Responses

Assessment Type	Nature of Deficiencies Documentation	Individual(s) Notified of Findings	Timeframe of Notification	Nature of Corrective Action Response Documentation	Individual(s) Receiving Corrective Action Response	Timeframe for Response
Field Observations /Deviations from Work Plan	Logbook	GSC Field Technician(s) GSC FSM	Immediately	Field Change Form	GSC PM GSC FSM GSC QAM	Within 24 hours of change
Data Verification	Communication may be in the form of email traffic requesting additional laboratory forms, backup data that may be missing, and / or clarification of the analytical report	Laboratory PM	Upon finding deficiency	If required, laboratory reports will be amended and corrections noted in the analytical narrative and contained within the validation report.	Veridian PM	Up to 7 days
Validation	Communication may be in the form of email traffic requesting additional laboratory forms, backup data that may be missing, and / or clarification of the analytical report	Laboratory PM	Upon finding deficiency	If required, laboratory reports will be amended and corrections noted in the analytical narrative and contained within the validation report.	Veridian PM	Up to 7 days
External Lab Performance Audits	Audit Report	Laboratory Manager	Within 30 Days	Corrective Action Plan	Regulatory Agency	Within 30 Days
Peer Review	In the deliverable	GSC PM	Prior to deliverable due date	Comments directly in the deliverable	GSC PD	Prior to deliverable due date

QAPP Worksheet #33: QA Management Reports Table

Type of Report	Frequency	Projected Delivery Date(s)	Person(s) Responsible for Report Preparation (Title and Organizational Affiliation)	Report Recipient(s) (Title and Organizational Affiliation)
Progress Report	Monthly	10^{th} of the month following performance period	GSC PM IBM PM / QAM	EPA RPM
Validation Report	For each round of groundwater, surface water, sediments sampling	30 days after completion of analytical data	Veridian PM Veridian QAM	GSC PM
Comprehensive 5-year Review	At least every 5 years	To be determined (TBD)	GSC PD GSC PM IBM PM	EPA RPM

QAPP Worksheet #34: Verification (Step I) Process Table

Verification Input	Description	Internal or External	Responsible for Verification (Name, Organization)
Field Staff Training	Personnel assigned to the project, including field personnel and subcontractors, will be qualified to perform the tasks to which they are assigned. Field personnel will have basic field investigation knowledge for multimedia sampling. This includes, but is not limited to, sampling techniques, field testing methodology, and task-specific sampling methods, decontamination of field sampling equipment, maintenance of environmental paperwork, and how to avoid cross-contamination. In addition to education and experience, specific training may be required to qualify individuals to perform certain activities. Training will be documented appropriately and the forms placed in the project file as a record. Project personnel will receive an orientation to the full project-specific CMP and QAPP as appropriate to their responsibilities before participation in project activities. Training of field personnel will be provided by the Site Supervisor, the QA Officer, or by a qualified designee.	Internal	GSC PM
CMP (including QAPP)	A copy of the reviewed and approved version of the CMP (including QAPP) will be distributed and be available for review by all personnel involved in this project.	Internal / External	GSC PM GSC FSM GSC QAM
Laboratory Certifications	All laboratories providing analytical services for this program will have the required laboratory certifications as specified in this document and the QMP.	External	GSC QAM
Sample Location Verification	The sample number will be traceable to the site, location, and depth (where applicable). The sample identification and description will be recorded by the Field Technician on the Sampling Field Data Sheet. The Daily reviews of field log books will be conducted on each day of sampling.	Internal	GSC Scientist
Chain of Custody Record	Reviewed by Field Sampling Personnel in field and Data QA/QC Group prior to final analytical report preparation	Internal	GSC
Laboratory Data Package	Reviewed for completeness	Internal	TestAmerica Burlington and EnviroTest Laboratories Veridian Chemist
Analytical Report	Reviewed for accuracy	Internal	Veridian Chemist Veridian PM
Reporting	Reviewed for accuracy	Internal	Peer Review Team

QAPP Worksheet #35: Validation (Steps IIa and IIb) Process Table

Step IIa/IIb	Validation Input	Description	Responsible for Validation (Name, Organization)
IIa	SOPs	Ensure that the sampling methods/procedures outlined in the QAPP were followed and any deviations noted	GSC QAM
IIa	COC records	Examine COC records and match with requested analyses	GSC QAM
IIa	Lab Data Package	Examine packages against COC forms (holding times, sample handling, methods, sample identifications, qualifiers)	Veridian Chemist Veridian PM
IIb	Lab Data Package	Quantify data based on QC deficiencies (precision/accuracy, %RSD, %D, etc.)	Veridian Chemist Veridian PM

Validation associated with Step II a will be conducted by an entity at least one step removed from the entity that generated the data. In the case of this project, field sampling data will be conducted by GSC personnel not directly responsible for the field sampling activities and laboratory analytical data will be validated by a third-party (Veridian). Validation associated with Step IIb, comparison to Quality Objectives of the QAPP, will be conducted by a third-party (Veridian). Worksheet #36 provides a summary of validation criteria.

QAPP Worksheet #36: Validation (Steps IIa and IIb) Summary Table

Data Validator: Veridian Environmental Inc.

Matrix	Analytical Group	Concentration Level	Validation Criteria
Groundwater, Surface Water	Volatile Organics EPA SW-846 8260B	Low	USEPA Hazardous Waste Support Section, SOP No. HW-33 Revision 3, Low/Medium Volatile Data Validation, March 2013
Groundwater	Dissolved Gases RSK-175	Not applicable	As per Method and Laboratory SOP
Groundwater	Inorganics by Ion Chromatography	Not applicable	As per Method and Laboratory SOP
Groundwater	Determination of Metals EPA 200.8 and EPA 6020A	Not applicable	As per Method and Laboratory SOP
Soil	Volatile Organics EPA SW-846 8260B	Low	USEPA Hazardous Waste Support Section, SOP No. HW-33 Revision 3, Low/Medium Volatile Data Validation, March 2013
Soil	Total Organic Carbon Lloyd Kahn Method	Not applicable	As per Method and Laboratory SOP

100% of the data packages will undergo EPA Level III validation
10% of the results will undergo EPA Level IV validation

DATA QUALIFIER DEFINITIONS

U	The analyte was analyzed for, but was not detected above the level of the reported sample quantitation limit.
J	The result is an estimated quantity. The associated numerical value is the approximate concentration of the analyte in the sample.
J+	The result is an estimated quantity, but the result may be biased high.
J-	The result is an estimated quantity, but the result may be biased low.
NJ	The analysis indicates the presence of an analyte that has been "tentatively identified" and the associated numerical value represents its approximate concentration.
UJ	The analyte was analyzed for, but was not detected. The reported quantitation limit is approximate and may be inaccurate or imprecise.
R	The data are unusable. The sample results are rejected due to serious deficiencies in meeting Quality Control (QC) criteria. The analyte may or may not be present in the sample.

QAPP Worksheet #37: Usability Assessment

Summarize the usability assessment process and all procedures, including interim steps and any statistics, equations, and computer algorithms that will be used:
Describe the evaluative procedures used to assess overall measurement error associated with the project:
Identify the personnel responsible for performing the usability assessment: Veridian
Describe the documentation that will be generated during usability assessment and how usability assessment results will be presented so that they identify trends, relationships (correlations), and anomalies:

The general quality objectives of this project are to characterize groundwater, surface water, sediments and other media, and to collect hydrogeologic data of sufficient quality, quantity, and precision to describe the subsurface conditions at the site, determine the nature and extent of contamination. A secondary objective is to provide analytical and physical measurements that are fully documented, supported, and defensible. The quality assurance (QA) program will incorporate quality control (QC) procedures for field sampling and field measurements, chain of custody, laboratory analyses, and reporting to ensure generation of sound analytical results and physical data.

Performance acceptance criteria are expressed in terms of six data quality indicators (DQIs): precision, bias, representativeness, comparability, completeness, and sensitivity. An explanation of each DQI, together with the acceptance criteria for each DQI is presented below.

Data assessment will be performed in accordance with EPA guidance QA/G-9R, Data Quality Assessment, A Reviewer's Guide (EPA/240/B-06/002) dated February 2006. In accordance with EPA guidance, a data assessment is intended to provide documentation that clearly demonstrates that the collected data are of the right type, quality, and quantity to meet the objectives of the project. A comprehensive evaluation of how the data meet precision, accuracy, representativeness, comparability, and completeness (PARCC) objectives will also be performed for this remedial investigation.

The data usability assessment will reconcile the data quality objectives of this QAPP to the results of the data collection and analytical results, data validation evaluation (as applicable), and field quality control results.

Data quality indicators, such as precision, accuracy, completeness, representativeness, and comparability measurements, aid in the evaluation process and are discussed in the following subsections.

Precision

Precision is a measure of mutual agreement among individual measurements of the same property under prescribed similar conditions. Precision is independent of the error (accuracy) of the analyses and reflects only the degree to which the measurements agree with one another, not the degree to which they agree with the "true" value for the parameter being measured.

Precision of the measurement data for this project is based on control sample analyses (for repeatability) and results of field duplicate samples (for sampling replicability). A field duplicate is defined as a sample that is divided into two equal parts for the purpose of analysis. Discretely sampled field duplicates are useful in determining sampling variability, and field duplicates will be used as a quality control measure to monitor precision relative to sample collection activities. Field duplicate frequency will be five percent of the original sample number or as specified in the RI/FS work plan. Field duplicates will be collected for groundwater only and will be analyzed for the same parameters as the original sample.

The most commonly used estimates of precision are the relative percent difference (RPD) for cases in which only two measurements are available, and the percent relative standard deviation (%RSD) when three or more measurements are available. This is especially useful in normalizing environmental measurements to determine acceptability ranges for precision because it effectively corrects for the wide variability in sample analyte concentration indigenous to samples.

Precision is represented as the RPD between measurement of an analyte in duplicate samples or in duplicate spikes. RPD is defined as follows:

$$\mathbf{RPD} = \frac{|C1 - C2|}{\frac{C1 + C2}{2}} \mathbf{\ x\ 100}$$

Where:

C_1 = First measurement value
C_2 = Second measurement value

Acceptance criteria for laboratory precision will be as specified in the analytical method. RPDs will be compared to the laboratory-established RPD for the analysis. The analyst or his/her supervisor must investigate the cause of data outside stated acceptance limits. Follow-up action includes recalibration, reanalysis of QC samples, sample reanalysis, or flagging the data as suspect if problems cannot be resolved. Precision of duplicates may depend on sample homogeneity. The RPD for duplicate investigative sample analysis provides a tool for evaluating how well the method performed for the respective matrix. For this project, the acceptance criteria for field duplicate samples will be 30% for parameter concentrations greater than 10 micrograms per liter (ug/l) and 50% for concentrations less than 10 ug/l.

The % RSD is calculated by the standard deviation of the analytical results of the replicate determinations relative to the average of those results for a given analyte. This method of precision measurement can be expressed by the formula:

$$\%\,\mathbf{RSD} = \frac{\sqrt{\sum_{I-1}^{N}\left(\frac{\mathbf{RF_i - RF}}{\mathbf{N-1}}\right)}}{\mathrm{RF}}\ \mathbf{x\ 100}$$

Where:
RF = Response Factor
N = Number of Measurements

Precision control limits for evaluation of sample results are established by the analysis of control samples. The control samples can be method blanks fortified with surrogates (e.g., for organics), or laboratory control samples (LCS) purchased commercially or prepared at the laboratory. The LCS is typically identified as blank spikes (BS) for organic analyses. For multi-analyte methods, the LCS or BS may contain only a representative number of target analytes rather than the full list.

Accuracy/Bias

Bias is the systematic or persistent distortion of a measurement process causing errors in one direction. Depending on the analytical method, analytical bias will be evaluated by analysis of laboratory control spike / laboratory control spike duplicate (LCS/LCSD) or matrix spike / matrix spike duplicate (MS/MSD) samples. The laboratory will perform a LCS/LCSD or MS/MSD for each analytical batch, as appropriate.

Accuracy control limits are established by the analysis of control samples, which are water and/or solid/waste matrices. For organic analyses, the LCS may be a surrogate compound in the blank or a select number of target analytes in the blank spike. The LCS is subjected to all sample preparation steps. When available, a solid LCS may be analyzed to demonstrate control of the analysis for soil. The amount of each analyte recovered in an LCS analysis is recorded and entered into a database to generate statistical control limits. These empirical data are compared with available method reference criteria and available databases to establish control criteria.

The percent recovery (% R) for spiked investigative sample analysis (e.g., matrix spike) provides a tool for evaluating how well the method worked for the respective matrix. These values are used to assess a reported result within the context of the project data quality objectives. For results that are outside control limits provided as requirements in the QAPP, corrective action appropriate to the project will be taken and the deviation will be noted in the case narrative accompanying the sample results. Percent recovery is defined as follows:

$$\% \text{ Recovery} = \frac{A_T - A_0}{A_F} \text{ x } 100$$

Where:

A_T = Total amount recovered in fortified sample
A_0 = Amount recovered in unfortified sample
A_F = Amount added to sample

Acceptance criteria for LCS/LCSD and MS/MSD measurements will be expressed as a percent recovery and are specified in the analytical method and in the USEPA Hazardous Waste Support Section, SOP No. HW-33 Revision 3, Low/Medium Volatile Data Validation, March 2013. Various blank samples (such as laboratory method blanks and field equipment rinse blanks) will also be used to assess contamination of samples that may bias results high.

Accuracy for some procedures is evaluated as the degree of agreement between a new set of results and a historical database or a table of acceptable criteria for a given parameter. This is measured as percent difference (%D) from the reference value, and is primarily used by the laboratory as a means for documenting acceptability of continuing calibration.

The %D is calculated by expressing, as a percentage, the difference between the original value and new value relative to the original value. This method for precision measurement can be expressed by the formula:

$$\%D = \frac{C_1 - C_2}{C_1} \text{ x } 100$$

Where:

C_1 = Concentration of analyte in the initial aliquot of the sample
C_2 = Concentration of analyte in replicate

Completeness

Completeness is a measure of the amount of valid data obtained from a measurement system compared to the amount expected to be obtained under normal conditions.

Data completeness is a measure of the extent to which the database resulting from a measurement effort fulfills objectives for the amount of data required. Valid analyses are defined as those where the sample arrived at the laboratory intact, properly preserved, in sufficient quantity to perform the requested analyses, and accompanied by a completed chain of custody. Furthermore, the sample was analyzed within the specified holding time and in such a manner that analytical QC acceptance criteria were met. Completeness for the entire project also involves completeness of field and laboratory documentation, whether all samples and analyses specified in this plan have been processed and the procedures specified in the work plans and laboratory Quality Assurance Project Plans (QAPPs) and Standard Operating Procedures (SOPs) have been implemented.

Site-wide completeness goals account for all aspects of sample handling, from collection through data reporting. The level of completeness can be affected by loss or breakage of samples during transport, as well as external problems that prohibit collection of the sample. The following calculation is used for determining the percent complete:

$$\text{Completeness} = \frac{A}{B} \text{ x } 100$$

Where:

A= Number of usable data points.
B= Total number of data points collected

The formula for sampling completeness is :

$$\text{Sampling Completeness} = \frac{\text{Number of locations samples}}{\text{Number of planned sample locations}} \text{x}100$$

An example formula for analytical completeness is:

$$\text{VOC Analytical Completeness} = \frac{\text{Number of Usable Data Points}}{\text{Expected Number of Usable Data Points}} \text{x}100$$

The ability to meet or exceed completeness objectives is dependent on the nature of samples submitted for analysis.

The following table lists the completeness goals for this program. If the completeness goal is not met because of controllable circumstances, then the samples will be recollected and reanalyzed, as necessary, to meet the completeness objective. If the completeness goal is not met because of uncontrollable circumstances, such as inaccessible sample points, matrix interferences, etc., then the deficiency will be evaluated. For this project as a whole, a completeness value of 90 percent is considered acceptable. Failure to achieve this goal may necessitate re-sampling and reanalysis.

Project Completeness Goals

Task	Subtask	Completeness Goal
Sampling	Sample Collection	90%
Analytical Measurements	All laboratory analyses	95% of collected analytes

Representativeness

Representativeness expresses the degree to which data accurately and precisely represents a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition. Existing chemical concentration data available for the Site, coupled with the broad geographic and temporal distribution of these data is such that the Comprehensive Monitoring Plan developed for the Site is believed to accurately reflect the state of the whole system.

The characteristics of representativeness are usually not quantifiable. Subjective factors to be taken into account are as follows:

1. Degree of homogeneity of a site.
2. Degree of homogeneity of a sample taken from one point in a site.
3. Available information on which a sampling plan is based.

Field duplication, as defined above under precision, is also used to assess representativeness. Two samples collected at the same location and at the same time are considered to be equally representative of this condition at a given point in space and time. To maximize representativeness of results, sampling techniques, sample size, and sample locations are carefully chosen so they provide laboratory samples representative of the Site and the specific area. For this project, the only quantitative measure of representativeness will be the field duplicate results as discussed in the Precision Section.

Data representativeness for this project is accomplished by implementing approved sampling procedures and analytical methods that are appropriate for the intended data uses, and which are established within this QAPP and the CMP.

Comparability

Comparability expresses the confidence with which one data set can be compared to another data set measuring the same property. Comparability is ensured through the use of established and approved sample collection techniques and analytical methods, consistency in the basis of analysis (wet weight, volume, etc.), consistency in reporting units, and analysis of standard reference materials.
Data comparability is achieved by using standard units of measure. The use of standard methods to collect and analyze samples, along with instruments calibrated against Standard Analytical Reference Materials (SARM), which are National Institute for Standards and Technology (NIST) -traceable standards, also ensures comparability.

Comparability also depends on the other data quality characteristics. Only when data are judged to be representative of the environmental conditions, and when precision and accuracy are known, can data sets be compared with confidence.

Comparability of data sets generated for this project will be obtained through the implementation of standard sampling and analysis procedures, by the use of traceable reference materials for laboratory standards, and by expressing the results in comparable concentration units.

Sensitivity/Selectivity

Sensitivity is essentially the lowest detection limit of the method or instruments for each of the measurement parameters of interest. Technically, it is the capability of a method or instrument to discriminate between measurement responses representing different levels of the variable of interest.

Quantitation limits are based on the extent to which the laboratory or field equipment, and/or analytical process itself can provide accurate, minimum data measurements of a reliable quality for specific constituents in actual field samples. The actual quantitation limit for a given analysis varies depending on instrument sensitivity, preparation, method efficiency, and matrix effects. The minimum project requirements are considered when establishing the quantitation limits appropriate for each project.

The target analytes, expected detection limits (for samples not requiring serial dilution), and practical quantitation limits (PQLs) for VOC analysis of aqueous samples will be those listed in the Appendix 33 Groundwater Monitoring List (6NYCRR Subpart 373-2). PQLs are the lowest concentrations of analytes in groundwater that can be reliably determined within specified limits of precision and accuracy by the indicated methods under routine laboratory operating conditions. The PQLs listed are generally stated to one significant figure. PQLs are based on 5 ml samples for volatile organics. The PQL values in many cases are based only on a general estimate for the method and not on a determination for individual compounds; PQLs are not a part of the regulation.

Sensitivity is the ability of the method or acceptable sensitivity instrument to detect the contaminant of concern and other target compounds at the level of interest. Quantitative measurement performance criteria need to be determined for acceptable sensitivity to ensure that the quantitation limits can be routinely achieved for each matrix, analytical parameter, and concentration level. The use of standards and instrument calibration will enable the instrument to identify and differentiate between various compounds/analytes of interest and interferences.

Assessment of Data Usability

In addition, data assessment is considered the final step in the data evaluation process and can be performed only on data of known and documented quality. Section 36 will establish what type of formalized evaluation/validation process (per EPA protocol) the project-specific analytical data will undergo. For this project, all data will be assessed for usability by the Veridian Program Chemist, regardless of the data evaluation/validation process implemented. As mentioned previously, data usability goes beyond validation in that it evaluates the achievement of the DQOs based on the comparison of the project DQIs (previously defined in the QAPP) and specific work plans, with the obtained results. The results of the data usability assessment, and particularly any changes to the DQOs necessitated by the data not meeting usability criteria, will be included in each final report.

Sampling and Analysis Activities Evaluation

The first step of the data usability evaluation will include a review of the sampling and analysis activities in comparison to Site-Wide DQIs and study-specific work plans. Specific limitations to the data, i.e., results that are qualified as estimated (J/UJ), or rejected (R), will be determined and documented in the database. The data acquisition and evaluation process consists of a series of procedures that were designed to maximize final data quality.

Achievement of DQIs

The second part of data usability pertains to the achievement of the program-specific DQIs. Each investigator will compare the performance achieved for each data quality criterion against the expected and planned performance. In general, this comparison will follow from the DQIs used to define each DQO. This comparison is the most critical component of the assessment process. Any deviation from planned performance will be documented and evaluated to determine whether corrective action is advisable. Potential corrective actions will range from resampling and/or reanalysis of data, to qualification or exclusion of the data for use in the data interpretation. In the event that corrective action is not possible, the limitations, if any, of the data with regard to achieving the DQOs will be noted.

In conjunction with the DQI achievement review, the investigators will need to make decisions for the use of qualified values, which are a consequence of the formalized evaluation/validation process. Data qualifiers will be applied to individual data results. Data usability decisions will be made based on the assessment of the usability of each of these results for the intended purpose. Evaluation will describe the uncertainty (e.g., bias, imprecision) of the qualified results. Cumulative QC exceedances from the DQIs may require technical judgment to determine the overall effect on the usability of the data. Decisions about usability of qualified data for use in risk assessment will be based on the EPA document mentioned, which allows for the use of estimated values. Finally, data users may choose to determine final data usability qualifiers as a result of this overall examination and decision process.

Achievement of DQOs

The third step in the data usability process concerns achievement of the DQOs. Once the data set has been assessed to be of known quality, data limitations have been documented, and overall result applicability/usability for its intended purpose has been determined, the final data assessment can be initiated by considering the answers to the following questions:

> Are the data adequate to determine the extent to which hazardous substances have migrated or to what extent they are expected to migrate from the source area;
>
> Do the data collected allow assessment of hydrogeologic factors, which may influence contaminant migration/distribution;
>
> Have sufficient data been collected to evaluate trends in concentrations of Site COCs.

The principal investigators, in conjunction with the project team, will need to formulate solutions if data gaps are found as a result of problems, biases, or trends in the analytical data, or if conditions exist that were not anticipated in the development of the DQOs. It is particularly important that each data usability evaluation specifically address any limitations on the use of the data that may result from a failure to achieve the stipulated DQO.

APPENDIX A: QC Tables for Volatile Organic Compounds

Recovery and Precision Limits
Matrix: Aqueous
SOP: BR-MV-006 (See Worksheet #23)
Analytical Group: Volatile Organic Compounds

Analyte	CAS #	Precision (RPD)	Recovery Limits (LCS/MS/MSD)
1,1,1,2-Tetrachloroethane	630-20-6	30	85-120
1,1,1-Trichloroethane	71-55-6	30	85-120
1,1,2,2-Tetrachloroethane	79-34-5	30	85-120
1,1,2-Trichloroethane	79-00-5	30	85-120
1,1-Dichloroethane	75-34-3	30	85-120
1,1-Dichloroethene	75-35-4	30	85-120
1,1-Dichloropropene	563-58-6	30	80-120
1,2,3-Trichlorobenzene	87-61-6	30	85-120
1,2,3-Trichloropropane	96-18-4	30	80-115
1,2,4-Trichlorobenzene	120-82-1	30	85-120
1,2,4-Trimethylbenzene	95-63-6	30	85-120
1,2-Dibromo-3-Chloropropane	96-12-8	30	85-120
1,2-Dibromoethane	106-93-4	30	85-120
1,2-Dichlorobenzene	95-50-1	30	85-120
1,2-Dichloroethane	107-06-2	30	80-115
1,2-Dichloropropane	78-87-5	30	85-120
1,3,5-Trimethylbenzene	108-67-8	30	85-120
1,3-Dichlorobenzene	541-73-1	30	85-120
1,3-Dichloropropane	142-28-9	30	80-120
1,4-Dichlorobenzene	106-46-7	30	85-120
1,4-Dioxane	123-91-1	30	50-145
2,2-Dichloropropane	594-20-7	30	80-120
2-Butanone	78-93-3	30	75-130
2-Chloroethyl vinyl ether	110-75-8	30	85-120
2-Chlorotoluene	95-49-8	30	85-120
2-Hexanone	591-78-6	30	70-140
4-Chlorotoluene	106-43-4	30	85-120
4-Isopropyltoluene	99-87-6	30	85-120
4-Methyl-2-pentanone	108-10-1	30	80-120
Acetone	67-64-1	30	55-135
Benzene	71-43-2	30	85-120
Bromobenzene	108-86-1	30	85-120
Bromochloromethane	74-97-5	30	85-120
Bromodichloromethane	75-27-4	30	85-120
Bromoform	75-25-2	30	85-120
Bromomethane	74-83-9	30	55-150
Carbon disulfide	75-15-0	30	85-120
Carbon tetrachloride	56-23-5	30	80-120
Chlorobenzene	108-90-7	30	85-120
Chloroethane	75-00-3	30	80-125
Chloroform	67-66-3	30	85-120
Chloromethane	74-87-3	30	65-145
cis-1,2-Dichloroethene	156-59-2	30	85-120
cis-1,3-Dichloropropene	10061-01-5	30	85-120
Cyclohexane	110-82-7	30	60-140

Dibromochloromethane	124-48-1	30	85-120
Dibromomethane	74-95-3	30	85-120
Dichlorodifluoromethane	75-71-8	30	35-190
Ethylbenzene	100-41-4	30	85-120
Freon TF	76-13-1	30	85-120
Hexachlorobutadiene	87-68-3	30	80-125
Isobutyl alcohol	78-83-1	30	55-145
Isopropylbenzene	98-82-8	30	55-120
m&p-Xylene	179601-23-1	30	85-120
Methyl acetate	79-20-9	30	60-140
Methyl iodide	74-88-4	30	65-150
Methyl t-butyl ether	1634-04-4	30	85-120
Methylcyclohexane	108-87-2	30	60-140
Methylene Chloride	75-09-2	30	85-120
Naphthalene	91-20-3	30	85-125
n-Butylbenzene	104-51-8	30	85-120
n-Propylbenzene	103-65-1	30	85-120
o-Xylene	95-47-6	30	85-120
sec-Butylbenzene	135-98-8	30	85-120
Styrene	100-42-5	30	85-120
tert-Butylbenzene	98-06-6	30	85-120
Tetrachloroethene	127-18-4	30	85-120
Tetrahydrofuran	109-99-9	30	80-125
Toluene	108-88-3	30	85-120
trans-1,2-Dichloroethene	156-60-5	30	85-120
trans-1,3-Dichloropropene	10061-02-6	30	85-120
Trichloroethene	79-01-6	30	85-120
Trichlorofluoromethane	75-69-4	30	70-130
Vinyl acetate	108-05-4	30	60-160
Vinyl chloride	75-01-4	30	85-120
Xylenes, Total	1330-20-7	30	85-120
1,2-Dichloroethane-d4 (Surrogate)	17060-07-0		80-115
Toluene-d8 (Surrogate)	2037-26-5		80-115
Bromofluorobenzene (Surrogate)	460-00-4		85-120
1,2-Dichlorobenzene-d4 (Surrogate)	2199-69-1		80-115

[1] *Laboratory historical control limits are subject to change as a result of periodic re-evaluation.*

Recovery and Precision Limits
Matrix: Solid / Sediment
SOP: BR-MV-006 (See Worksheet #23)
Analytical Group: Volatile Organic Compounds

Analyte	CAS #	Precision (RPD)	Recovery Limits (LCS/MS/MSD)
1,1,1,2-Tetrachloroethane	630-20-6	30	80-115
1,1,1-Trichloroethane	71-55-6	30	80-115
1,1,2,2-Tetrachloroethane	79-34-5	30	75-125
1,1,2-Trichloroethane	79-00-5	30	75-125
1,1-Dichloroethane	75-34-3	30	85-120
1,1-Dichloroethene	75-35-4	30	75-135
1,1-Dichloropropene	563-58-6	30	85-120
1,2,3-Trichlorobenzene	87-61-6	30	70-125
1,2,3-Trichloropropane	96-18-4	30	70-125
1,2,4-Trichlorobenzene	120-82-1	30	80-125
1,2,4-Trimethylbenzene	95-63-6	30	85-120
1,2-Dibromo-3-Chloropropane	96-12-8	30	65-130
1,2-Dibromoethane	106-93-4	30	80-120
1,2-Dichlorobenzene	95-50-1	30	85-120
1,2-Dichloroethane	107-06-2	30	75-120
1,2-Dichloropropane	78-87-5	30	85-120
1,3,5-Trimethylbenzene	108-67-8	30	85-120
1,3-Dichlorobenzene	541-73-1	30	80-120
1,3-Dichloropropane	142-28-9	30	85-120
1,4-Dichlorobenzene	106-46-7	30	85-120
1,4-Dioxane	123-91-1	30	50-160
2,2-Dichloropropane	594-20-7	30	85-120
2-Butanone	78-93-3	30	70-135
2-Chloroethyl vinyl ether	110-75-8	30	65-145
2-Chlorotoluene	95-49-8	30	85-120
2-Hexanone	591-78-6	30	70-135
4-Chlorotoluene	106-43-4	30	85-120
4-Isopropyltoluene	99-87-6	30	85-120
4-Methyl-2-pentanone	108-10-1	30	65-135
Acetone	67-64-1	30	50-130
Benzene	71-43-2	30	85-120
Bromobenzene	108-86-1	30	85-120
Bromochloromethane	74-97-5	30	75-125
Bromodichloromethane	75-27-4	30	80-115
Bromoform	75-25-2	30	75-130
Bromomethane	74-83-9	30	65-145
Carbon disulfide	75-15-0	30	80-135
Carbon tetrachloride	56-23-5	30	80-115
Chlorobenzene	108-90-7	30	80-120
Chloroethane	75-00-3	30	70-135
Chloroform	67-66-3	30	85-120
Chloromethane	74-87-3	30	55-150
cis-1,2-Dichloroethene	156-59-2	30	80-120
cis-1,3-Dichloropropene	10061-01-5	30	85-120
Cyclohexane	110-82-7	30	60-140

Dibromochloromethane	124-48-1	30	80-120
Dibromomethane	74-95-3	30	80-120
Dichlorodifluoromethane	75-71-8	30	30-180
Ethylbenzene	100-41-4	30	80-120
Freon TF	76-13-1	30	75-140
Hexachlorobutadiene	87-68-3	30	65-150
Isobutyl alcohol	78-83-1	30	70-135
Isopropylbenzene	98-82-8	30	85-120
m&p-Xylene	179601-23-1	30	80-120
Methyl acetate	79-20-9	30	60-140
Methyl iodide	74-88-4	30	70-150
Methyl t-butyl ether	1634-04-4	30	85-130
Methylcyclohexane	108-87-2	30	60-140
Methylene Chloride	75-09-2	30	75-140
Naphthalene	91-20-3	30	80-125
n-Butylbenzene	104-51-8	30	85-125
n-Propylbenzene	103-65-1	30	85-120
o-Xylene	95-47-6	30	85-120
sec-Butylbenzene	135-98-8	30	85-120
Styrene	100-42-5	30	80-125
tert-Butylbenzene	98-06-6	30	85-120
Tetrachloroethene	127-18-4	30	85-120
Tetrahydrofuran	109-99-9	30	75-125
Toluene	108-88-3	30	75-125
trans-1,2-Dichloroethene	156-60-5	30	80-130
trans-1,3-Dichloropropene	10061-02-6	30	85-120
Trichloroethene	79-01-6	30	85-120
Trichlorofluoromethane	75-69-4	30	70-140
Vinyl acetate	108-05-4	30	70-135
Vinyl chloride	75-01-4	30	65-145
Xylenes, Total	1330-20-7	30	85-120
1,2-Dichloroethane-d4 (Surrogate)	17060-07-0		65-155
Toluene-d8 (Surrogate)	2037-26-5		80-115
Bromofluorobenzene (Surrogate)	460-00-4		80-115
1,2-Dichlorobenzene-d4 (Surrogate)	2199-69-1		45-145

[1] *Laboratory historical control limits are subject to change as a result of periodic re-evaluation.*

APPENDIX B: QC Tables for Dissolved Gases

Recovery & Precision Limits
Matrix: Aqueous
SOP: BR-AT-006 (See Worksheet #23)
Analytical Group: Dissolved Gases

Analyte	CAS #	Precision (RPD)	Recovery Limits (LCS/MS/MSD)
Methane	74-82-8	30	70-130
Ethane	74-84-0	30	70-130
Ethylene	74-85-1	30	70-130

[1] Laboratory historical control limits are subject to change as a result of periodic re-evaluation.

Recovery & Precision Limits
Matrix: Aqueous
SOP: BR-AT-006 (See Worksheet #23)
Analytical Group: Dissolved Gases (Carbon Dioxide)

Analyte	CAS #	Precision (RPD)	Recovery Limits (LCS/MS/MSD)
Carbon Dioxide	124-38-9	30	70-130

[1] Laboratory historical control limits are subject to change as a result of periodic re-evaluation.

SHENANDOAH ROAD GROUNDWATER CONTAMINATION SUPERFUND SITE
TOWN OF EAST FISHKILL, DUTCHESS COUNTY, NEW YORK

Protocols and Standard Operating Procedures

Federal Superfund Identification Number: NYSFN0204269
NYSDEC Site Number: 3-14-104

Revisions to Final Approved Protocols and SOPs:

Revision #	Submitted Date	Summary of Revision	Approval Date

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ABBREVIATIONS / ACRONYMS

AOC	Administrative Order on Consent
AWSRA	Alternate Water Supply Response Action
bgs	below ground surface
cis-1,2-DCE	cis-1,2 dichloroethene
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CMP	comprehensive monitoring plan
COCs	constituents of concern
DNAPL	dense non-aqueous phase liquid
EPA	United States Environmental Protection Agency Region
FS:	feasibility study
GAC	granular activated carbon
gpm	gallons per minute
GSC	Groundwater Sciences Corporation
GSPC	Groundwater Sciences, P.C.
HDPE	high-density polyethylene
IBM	International Business Machines
IGI	Initial Groundwater Investigation
MNA	monitored natural attenuation
MCL	maximum contaminant level
NTCSRA	Non-Time-Critical Source Removal Action
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
OM&M	Operations, Maintenance and Monitoring
PCE	tetrachloroethene
POET	point of entry treatment
PVC	polyvinyl chloride
QAPP	quality assurance project plan
ROD	record of decision
RD/RA	remedial design / remedial action

RI	remedial investigation
RI/FS	remedial investigation/feasibility study
RSCOs	recommended soil cleanup objectives
SCGs	standards, guidance and criteria
SETS	source extraction and treatment system
SOW	statement of work
SLERA	Screening Level Ecological Risk Assessment
SRST	Shenandoah Road Service Territory
STWD	Shenandoah Town Water District
TAGM	Technical and Administrative Guidance Memorandum
TAL	target analyte list
TCE	trichloroethene
TCL	target compound list
TCLP	toxicity characteristic leaching procedure
ug/L	micrograms per Liter
ug/m^3	micrograms per cubic meter
VC	vinyl chloride
VOCs	volatile organic compounds

1.0 MONITORING WELL MAINTENANCE & DECOMMISSIONING PROTOCOL

This section describes monitoring well maintenance and inspection protocols. In addition, this section describes the actions that will be taken when a well in the groundwater monitoring network cannot provide representative groundwater elevations or water quality data.

1.1 Surface Completions

The surface soil around the outer casing will be excavated to a depth of 36 inches and a protective concrete apron will be formed using an 18-inch to 24-inch sonotube centered on the protector pipe or casing.

The steel well casing or protector pipe, when installed and grouted, will extend above the ground surface approximately 2.5 feet. When site-specific activities prevent this type of completion or the property owner does not want well casing to extend above the ground surface, the riser pipe and outer casing (if present) will be located below grade inside a manhole.

In the case of an above-ground completion, an expanding water-tight plug will be installed in the PVC riser pipe and a locking cap will be installed on the outer casing or protector pipe. Vent holes may be drilled, if necessary, in both the PVC riser pipe and in the outer casing to allow equalization of casing pressures with the atmosphere. The outer protective casing may require at least one weep hole for drainage. The weep hole should be a minimum of 1/4-inch diameter, just above the concrete inside the protective casing to prevent standing water from accumulating inside.

Where flush-mount surface completions are necessary, an expanding water-tight lockable plug will be installed in the PVC riser to prevent surface contaminants or water from entering the well.

1.2 Well Inspection and Maintenance

The groundwater monitoring system will be maintained to ensure that all monitoring points yield representative samples of high integrity. During each sampling event, all monitoring wells will be inspected for integrity. Only items discovered which will require maintenance will be documented in the comments section on the Field Sampling Data Sheet (Attachment A). Should a well or piezometer be found to be damaged beyond usability, blocked or broken, or fail to recharge properly or as expected, it will be repaired, or decommissioned and replaced as necessary. The well will be decommissioned according to the Well Decommissioning Protocol. Should any significant cracking or frost heaving of the surface seal be observed, repairs will be made and the measuring point resurveyed, to ensure accurate computation of groundwater elevations. All necessary repairs or replacements will be completed as soon as possible.

1.3 Well Decommissioning

This well decommissioning protocol has been approved by the New York State Department of Environmental Conservation (NYSDEC) for use at facilities in Dutchess County with similar well construction and geology to those present at the Site. As such, it meets NYSDEC's standards for well abandonment. The procedure is as follows:

1. Record historical data on Well Abandonment Form (Attachment A) before field work has begun and attach a well diagram.

2. Upon entering the field, verify well identification number by using a current site map.

3. Check depth to bottom using a weighted tape measure and compare to historical depth. If the well has silted in or caved more than three feet and there are recorded water-bearing zones in the obstructed portion of the borehole, remove the material from the bottom of the borehole before proceeding.

4. After verifying the above information, remove the protective casings and barriers.

5. Standpipes are to be cut one foot below grade and removed. Manholes should have all metal plates and covers removed.

6. If the well will be filled using bentonite slurry, proceed as follows (otherwise, proceed to step 7):

    a. Pump the well dry, if possible.

    b. Install a tremie pipe no less than five feet from the bottom of the borehole.

    c. Pump bentonite slurry through a tremie pipe when the slurry has a mud balance density of 10.2 lbs/gallon. (Maintain a record of mud balance results on the Mud balance Calibration Record, Attachment A.)

7. If the well is to be filled with bentonite chips, skip step 6, and proceed as follows:

    a. Slowly pour 3/8" bentonite chips into the borehole.

    b. Measure the level of chips in the borehole after each five-foot interval is filled.

8. Regardless of the material used to backfill the borehole, the following apply to the maximum level to which the well should be filled:

Standpipes should be filled to two feet below the top of casing after casing has been cut.

Manholes should be filled to two feet below the road or parking lot.

9. Allow 24 hours for settling to occur. If settling does occur, add more bentonite (chips or slurry).

10. Fill the remaining hole with concrete to provide a seal at the ground surface.

An alternative protocol may be used subject to EPA approval.

2.0 GROUNDWATER SAMPLING PROTOCOL

This section presents detailed procedures and protocols for presampling preparation and sample collection. Sample handling, documentation, field quality assurance sampling procedures and health and safety issues will also be discussed. The organization of this information generally follows the order in which these tasks will be performed.

Pre-sampling tasks will proceed as per SOP Section 5.0 prior to the initiation of sampling.

2.1 Water Level Measurements

Depth to water will be measured at all monitoring wells as per the schedule specified in the CMP in addition to static water level measurements conducted as part of water quality sampling activities. All static water level measurements will be obtained following this same procedure and will be recorded on a field form.

For wells with FLUTe multi-level device installations, depth to water measurements can be determined by direct reading of the transducer or by an electronic water level measuring device after purge of the pump tube following the manufacturer procedures (see Attachment D, *Guide for Use of Pressure Transducers with Water FLUTe*).

For wells without FLUTe multi-level device installations, depth to water measurements will be obtained using an electronic water level measuring device (M-scope® or equivalent) with 0.01 foot increments. These measurements will be taken at the designated permanent reference survey point marked on each well casing. In all instances, data will be reported and groundwater elevations calculated based on the measurement from the permanent reference survey point.

2.2 Groundwater Monitoring Well Purge Methods

Monitoring wells will be purged using one of the following configurations or equivalent methods:

- A dedicated or non-dedicated submersible pump constructed of stainless steel and Teflon® components equipped with appropriate low-sorption discharge tubing.
- A variable-speed Teflon®-and-stainless-steel submersible pump with low sorption discharge tubing.
- A dedicated multi-level sampling device (FLUTe).
- Other EPA approved methods.

If any of the above equipment is dedicated, it will be stored in the well or in a dedicated storage container (PVC canisters or plastic bags) between sampling rounds.

For sampling techniques where low-flow purging is appropriate, the purging and sampling will proceed as per the *U. S. Environmental Protection Agency, Region II, Ground Water Sampling*

Procedure, Low Stress (Low Flow) Purging and Sampling, Standard Operating Procedure (March 16, 1998) (see Attachment C, Quality Assurance Project Plan).

For sampling techniques where well purging is appropriate, the purge volume for each well will be calculated based on water level measurement, well depth measurement, and well diameter. The depth to bottom of the well will be sounded and the purge volume will be calculated using the following formula:

Purge Volume = *n x* (*Depth To Bottom –Depth To Water*) *x* 3	
Where *n* =	0.09 gal/ft for 1.5-inch diameter wells
	0.16 gal/ft for 2-inch diameter wells
	0.37 gal/ft for 3-inch diameter wells
	0.65 gal/ft for 4-inch diameter wells
	1.47 gal/ft for 6-inch diameter wells
	2.61 gal/ft for 8-inch diameter wells

The intake structure of any purge device will be positioned in a manner which allows for the removal of all stagnant water from the well. Confirmation of the removal of all stagnant water will be accomplished by verifying the drawdown of any pump used for purging.

2.3 Groundwater Containment / Disposal of Purge Water

Purge water from wells must be treated by sediment filtration and GAC VOC removal prior to being returned to the ground within a 20-foot radius of the well. In instances where purge water cannot be returned to the ground within a 20-foot radius of the well (e.g. paved area) and the well does not show evidence of the presence of non-aqueous phase liquid purge water will be properly disposed. If the presence of non-aqueous phase liquid is discovered in a well, that purge water will be contained and managed according to all appropriate State and Federal requirements.

2.4 Groundwater Sample Collection Methods

To ensure that a groundwater sample is representative, in all instances physical alteration of the sample will be minimized and chemical contamination must be prevented during the sampling process. The following is a list of sampling equipment and techniques that may be used to collect groundwater samples at this Site:

- *Teflon® or stainless steel bailers equipped with double check valves equipped with a bottom emptying device..* The bailers will be lowered slowly into the water column so as to minimize agitation of the water column. After the sample is brought to the surface, it will be emptied into the sample container using the bottom emptying device.

- *A variable-speed Teflon®-and-stainless-steel submersible pump.* The groundwater sample will be collected directly from the discharge line of the pump with the flow rate adjusted until as slow and steady a flow as possible is achieved.
- A dedicated multi-level sampling device (FLUTe).
- Other EPA approved methods.

All samples will be collected into laboratory prepared, properly preserved sample containers.

VOC samples will be transferred to sampling containers in such a way as to minimize agitation and aeration. VOC sample containers will be filled in such a manner as to have no headspace (air bubbles).

Field parameters (pH, specific conductance, turbidity and temperature) will be determined using a field meter after all samples have been collected following the sampling order specified in Table 2-1. The measurement will be recorded after the meter reading has stabilized (USEPA, Region 2, *Groundwater Sampling Procedure, Low Stress (Low Flow) Purging and Sampling, Standard Operating Procedure*, March 16, 1988). Field measurements will be recorded in the sampling log book and will be entered into the field parameters database. Sample collection will follow the priority listed in Table 2-1 below.

Table 2-1: Sample Collection Order

Priority	Parameter
1	Volatile Organics
2	Dissolved Oxygen
3	Nitrate
4	Field Parameters: pH Temperature Turbidity Specific Conductance

Samples will be collected into laboratory prepared sample containers for the required analytes as per SOP Section 11.0.

Field Quality Assurance / Quality Control Samples will be collected as per SOP Section 7.0.

Labels for bottles will include the sample station name, sample I.D. number and date and time of sample collection and will be prepared as per SOP Section 8.0.

Chain-of-custody forms will also be completed as per the procedures described in SOP Section 9.0.

Samples will be stored and shipped as per SOP Section 10.0.

3.0 SURFACE WATER SAMPLE COLLECTION METHOD

Pre-sampling tasks will proceed as per SOP Section 5.0 prior to the initiation of sampling.

Surface water samples will be collected using one of the following pieces of equipment:

- Teflon or glass beaker on extendable pole
- Teflon or stainless steel bailer with stainless steel wire or polypropylene or nylon rope

If more than one aliquot is needed to collect enough samples, a laboratory-cleaned glass compositing jug will be used. The compositing jug will be rinsed with sample water before actual sample collection. All sample bottles (except volatiles) will be filled from the compositing jug after the contents have been thoroughly mixed. Preservatives will be added to the bottles.

If volatiles analyses are requested, the vials will be filled directly from the stream, if possible. If not, the vials will be filled directly from the sampling device.

Samples will be collected into laboratory prepared sample containers for the required analytes as per SOP Section 11.0.

Field Quality Assurance / Quality Control Samples will be collected as per SOP Section 7.0.

Labels for bottles will include the sample station name, sample I.D. number and date and time of sample collection and will be prepared as per SOP Section 8.0.

Chain-of-custody forms will also be completed as per the procedures described in SOP Section 9.0.

Samples will be stored and shipped as per SOP Section 10.0.

4.0 SEDIMENTS SAMPLE COLLECTION METHOD

Pre-sampling tasks will proceed as per SOP Section 5.0 prior to the initiation of sampling.

A soil core tube made of stainless steel will be used to collect the samples. It will be properly decontaminated prior to use. Samples will be collected at either the mid-depth or mid-section of a stream or pond or at the seep outlet. Once collected, the sample will be transferred into laboratory provided sample containers. Once filled, sample bottles will be placed on ice.

Samples will be collected into laboratory prepared sample containers for the required analytes as per SOP Section 11.0.

Field Quality Assurance / Quality Control Samples will be collected as per SOP Section 7.0.

Labels for bottles will include the sample station name, sample I.D. number and date and time of sample collection and will be prepared as per SOP Section 8.0.

Chain-of-custody forms will also be completed as per the procedures described in SOP Section 9.0.

Samples will be stored and shipped as per SOP Section 10.0.

5.0 PRE-SAMPLING PREPARATION AND TASKS

This section describes the procedures to be followed by field sampling personnel prior to the initiation of the sampling event.

5.1 Field Equipment Inspection, Calibration and Maintenance

Prior to the sampling event, sampling equipment will be inspected to verify cleanliness and to ensure proper working order. Preventive maintenance of field measuring instruments and field sampling devices will be accomplished as per the manufacturer's specifications. All field equipment will be calibrated immediately prior to each day's use. Calibration procedures will conform to manufacturer's standard instructions.

5.2 Procurement and Preparation of Sample Containers

All samples will be collected into laboratory-prepared containers. Containers with preservative will be tagged as such by the laboratory. Field personnel will collect samples in appropriate containers for the required analytical methods.

5.3 Equipment Storage, Handling and Decontamination Procedures

Sampling equipment will be stored in a manner to prevent contact with contaminated equipment or materials. Whenever possible, dedicated sampling equipment will be used to reduce the need for field decontamination of equipment. Purging and sampling equipment must be handled with gloved hands. Gloves will be changed following each activity that may contaminate them and, at a minimum, between wells.

Since the hazardous constituents being monitored in groundwater at this Site are VOCs, all non-dedicated well evacuation devices will be decontaminated prior to placement down the borehole by high-pressure steam cleaning and thoroughly rinsing with organic-free deionized (DI) water.

Dedicated well evacuation and sampling equipment will be decontaminated in a similar way prior to being placed in service, and whenever it is removed for inspection and repair.

Other non-dedicated field measurement devices such as water level indicators and field parameter instruments will be decontaminated prior to obtaining a measurement in such a manner so as not to damage the equipment. This non-dedicated field equipment will be decontaminated by thoroughly rinsing with DI water.

6.0 PERSONNEL PROTECTIVE EQUIPMENT / HEALTH AND SAFETY MEASURES

A Health and Safety Plan (HASP) has been prepared specifically for the Site and is a self-contained document reproduced as Appendix BLANK to the RD/RA Work Plan. Section 4 of the HASP presents an assessment of chemical hazards identified at the Site as a result of extensive and continuing sampling efforts. Section 6 of the HASP describes the personal protective equipment required for sampling personnel.

Disposable nitrile gloves will be used for all sampling activities, regardless of the level of contamination. Gloves will be changed following each activity that may contaminate them and, at a minimum, between wells.

7.0 FIELD QUALITY ASSURANCE / QUALITY CONTROL REQUIREMENTS

Field Quality Assurance / Quality Control (Field QA/QC) requirements will be followed in the field to ensure the reliability and validity of field data gathered as part of the overall CMP. The field QA/QC program is based on the routine collection and analysis of three types of QC samples: trip blanks, duplicate samples, and equipment rinse blanks. All Field QA/QC samples will be entered onto the Chain of Custody along with the primary samples. Equipment rinse blanks and trip blanks will also be recorded on Field QA/QC index forms, a sample of which is provided in Attachment B.

7.1 Trip Blanks

Trip blanks are used to verify that VOC bottles and samples are not contaminated during transportation and storage. Trip blanks will be prepared by the laboratory and will accompany sample containers throughout the event from collection through shipment to the laboratory for analysis.

- One trip blank will be submitted for analysis for every twenty (20) samples collected or at a minimum of one trip blank per shipped cooler that contains VOC samples.

7.2 Field Duplicates

Field duplicates serve as a check on the validity of the sample, sampling technique and laboratory precision. Each field duplicates is assigned a unique sample identification number from the primary environmental sample. Field duplicates will be collected by alternating primary and field duplicate sample containers during sample collection.

- Field duplicates will be collected for all required analyses at a frequency of not less than 20 percent of the total number of environmental samples collected.

7.3 Equipment Rinse Blanks

Equipment rinse blanks will be collected in the field by passing laboratory supplied, analyte-free water over decontaminated non-dedicated equipment. Equipment rinse blanks confirm the effectiveness of decontamination procedures and will be analyzed for VOCs.

- Equipment Rinse Blanks will be collected once per sampling day from a piece of non-dedicated equipment, such as a water level indicator, non-dedicated purge pump, or sample bailer.

8.0 SAMPLE NUMBERING AND LABELING

A unique sample identification system will be used for all trip blanks, equipment blanks, duplicates, and environmental samples. All containers from one sample will be labeled with this unique identification number. Samples will be labeled as follows:

Environmental Sample	9999999YMMDD where 9999999 represents the location ID (e.g.S18D247); YMMDD is the date the sample was collected (e.g. 30312 = 2013, March 12)
Trip Blanks	STZYMMDDMMDD where S designates Shenandoah; T indicates the sample is a trip blank; Z designates the sampler id; Y is the last digit of the year (e.g. 3 = 2013); and MMDDMMDD is the period for which the trip blank is valid (e.g. 303110312 is March 11 through March 12)
Equipment Rinse Blanks	SEQYMMDDXXXX where S designates Shenandoah; EQ indicates the sample is an equipment rinse blank; YMMDD is the date that the rinse blank was collected and XXXX is an abbreviation for the type of rinse blank collected (e.g. BALR is bailer, PUMP is non-dedicated pump, WLID is water level indicator)

9.0 CHAIN OF CUSTODY PROCEDURES

The chain of custody allows for the tracing of possession and handling of individual samples from the time of field collection through laboratory analysis. The chain of custody form identifies each sample collected, the individuals responsible for sample collection, shipment and receipt. The intent of the chain-of-custody procedure is to provide guidance to maintain sample integrity.

Upon sample collection, but prior to storage shipment or transportation, the field personnel will properly and completely fill out the chain-of-custody form with a waterproof ink pen. If an error is made during the completion of the chain-of-custody form, a line will be drawn through the error and the correction entered. The field personnel completing the form will initial and date the error. Under no circumstances is white-out or erasing acceptable.

Preparation of the chain-of-custody form will be as follows:

- Complete the chain-of-custody form. The project name, client name, the person to whom the laboratory analytical report will be addressed and invoicing (Project Number) will be identified in the top section of the form;
- Each person taking possession of the sample(s) will sign and date the chain-of-custody as a recipient and will also sign and date the chain-of-custody upon relinquishment of the sample(s). When the sample(s) have been delivered to the laboratory, the laboratory sample custodian will sign off the chain-of-custody as the last recipient of the samples.
- Sample-specific information will include, at a minimum, unique sample identification number, date and time of sample collection, type of sample (e.g. groundwater), analyses requested, preservative (if any), volume/type of bottles, temperature of temperature blank in sample container (if necessary), and requested turn-around time. Any information relating to condition of samples upon receipt will be written on the Chain of Custody form as a comment.

10.0 SAMPLE STORAGE & SHIPMENT

In the field, samples will be kept in a cooler lined with ice until such time as the samples can be refrigerated or received at the laboratory. The temperature of samples will be checked and recorded on the chain-of-custody form upon receipt of the samples by the laboratory.

Samples will be hand-delivered to the laboratory or shipped via a commercial priority overnight delivery service. In cases where the samples leave the immediate control of the sampling team (i.e. shipment via common carrier), the shipping container must be sealed and a custody seal will be provided on the shipping container to ensure that the samples have not been disturbed during transport. Samples which are at all times in the possession of the field crew or their designee will not require custody seals on the coolers.

Samples must be sent to the laboratory as soon as practicable and should be received by the laboratory within 48 hours of sampling.

11.0 LABORATORY METHODS AND ANALYTICAL PROTOCOLS

All laboratories utilized under the CMP will have current and appropriate certification, New York State Department of Health Environmental Laboratory Program (NYSDOH ELAP), for the parameters analyzed. Laboratories performing the analyses must provide appropriate notice should certification lapse.

Laboratory analytical methods, documentation and reporting requirements are detailed in the following sections.

11.1 Analytical Methods, Sampling Containers, Preservatives and Holding Times

Table 11-1: Analytical Methods, Sample Containers, Preservatives, and Holding Times

Analytical Parameters or Measurements	Matrix	Analytical Method or Measurement Reference	Sample Volume, Containers and Preservative	Intended Use of Data
Sediment				
TCL VOCs	Solid	SW-846 Method 8260B, 5035	As per method	Characterize soil/sediment
Grain Size Dist.	Solid	ASTM Standard D422	As per method	Characterize soil/sediment
Total organic carbon	Solid	Walkley Black Method	As per method	Characterize soil/sediment
pH	Solid	SW-846 Method 9045C	As per method	Characterize soil/sediment
Percent Solids content	Solid	As per laboratory QAPP	As per method	Characterize soil/sediment
Groundwater/Surface Water				
TCL VOCs	Aqueous	SW-846 Method 8260B	As per method	Characterize groundwater or surface water
Nitrate-Nitrogen	Aqueous	As per laboratory QAPP	As per method	Characterize groundwater or surface water
Dissolved Oxygen	Aqueous	Field instrument	As per mfr.	Characterize groundwater or surface water
Conductivity	Aqueous	Field instrument	As per mfr.	Characterize groundwater or surface water
pH	Aqueous	Field instrument	As per mfr.	Characterize groundwater or surface water
Turbidity	Aqueous	Field instrument	As per mfr.	Characterize groundwater or surface water
Temperature	Aqueous	Field instrument	As per mfr.	Characterize groundwater or surface water

11.2 Documentation and Reporting Format

CLP deliverable reports will be prepared for samples collected and analyzed under this RD/RA work plan. Information regarding the analytical method, sample results, QA/QC results, chain of custody documentation, lab correspondence and raw data will be included in the CLP deliverables.

11.3 Laboratory Quality Assurance / Quality Control

Laboratories will follow all quality assurance / quality control procedures specified in the approved analytical methods. The quality assurance plans for each laboratory that may analyze samples for the Site under the CMP are reproduced in Attachment E.

12.0 FIELD ACTIVITY DOCUMENTATION FORMS

Daily Drilling and Monitoring Well Construction Report
Rock Classification Sheet
Soil Geologic Well Log
Field Operations Report
Teleview Inspection Log
Well Development Field Data Sheet
Sampling and Analysis Request Form
Calibration Record
Low-Flow Groundwater Purging and Sampling
Sampling Field Data Sheet
Field Sampling Data Sheet
Soil Sampling Field Data Sheet
Field Data Table
Physical Well Inventory
Well Decommissioning Form
Chain of Custody Record Example, EnviroTest Laboratories
Chain of Custody Record Example, TestAmerica Laboratories

Groundwater Sciences Corporation

Daily Drilling and Monitoring Well Construction Report

Date ____________________ **Page** _______ **of** _________

Project Number ______________________________________

Project Name ____

Supervising Geologist(s) ______________________________

Drilling Company ____

Rig Type/Number ____

Driller ____

Driller's Helper(s) _______________________________________

Daily Drilling Log

Well/Boring Number	Location	Type (HSA/Air)	Drilling (Ft/Dia.)	Core (Ft/Dia.)	Samples (No./Dia.)	Comments

Daily Activities Log

Time	Description	Hours	Time	Description	Hours
0630			1345		
0645			1400		
0700			1415		
0715			1430		
0730			1445		
0745			1500		
0800			1515		
0815			1530		
0830			1545		
0845			1600		
0900			1615		
0915			1630		
0930			1645		
0945			1700		
1000			1715		
1015			1730		
1030			1745		
1045			1800		
1100			1815		
1115			1830		
1130			1845		
1145			1900		
1200			1915		
1215			1930		
1230			1945		
1245			2000		
1300					
1315					
1330					

Materials Used

Well/Boring	Screen (ft./dia.)	Riser (ft./dia.)	Sand	Bentonite	Steel Casing	Other Materials

____

Signature - GSC

____

Signature - Contractor

Groundwater Sciences Corporation

Rock Classification Sheet

Project ________________________ Job. No. ______________ Sheet ________ of ________
Site Area ____ Drill Hole No. ____________
Contractor ______________ Driller _____________ Classified By ______________ Date _____________ Coordinates N/S________
E/W________

	Drilling History					Geologic Characteristics	Engineering Characteristics		Groundwater
Depth	Run No.	Core Rec.	Remarks	Well Constr.	Graphic Log	Description	Description	Discont.	Static Water Level Time & Date

SOIL GEOLOGIC WELL LOG **Project No.** ___________	**Total Depth** ___________ **Depth to S.S. Refusal** ___________ **Depth to Competent Bedrock** ___________ **Hole Diameter** ___________ **Notes** ___________	**Boring No.** ___________ **Location** ___________ **Driller** ___________ **Logged By** ___________ **Drilling Began** ___________ **Drilling Completed** ___________ **Well Construction Completed** ___________

					SAMPLE DESCRIPTION **Name: GRADE, DENSITY, MOISTURE, COLOR, STRUCTURE (USCS), ETC.**	**Volatile Scan**	**Graphic**		**Depth**
Depth	**Blow Counts**	**R Q D ft/ft**	**Recv**	**Sample # / Run #**			**Lith.**	**Well Construction**	

FIELD OPERATIONS REPORT

Project No. ___________

Total Depth ______________________________

Depth to S.S. Refusal ______________________

Depth to Competent Bedrock _______________

Hole Diameter ____________________________

Elev., Ground Surface ______________________

Boring No. ________________________

Location

Driller ___________________________

Logged By _________________________

Drilling Began ______________________

Drilling Completed ___________________

____

					SAMPLE DESCRIPTION (USCS), GRn. Size, Color, Shape, Texture, Moistness, etc.	%Grain Size				Other Notes	Graphic	Depth
Depth	Blow Count	RQD ft/ft	Recv ft/ft	Sample No./ Run No.		C	S	Sd	Gr			
2												
4												
6												
8												
0												
2												
4												
6												
8												
0												

TELEVIEW
INSPECTION LOG

Well ID # ____________________________ Date: ______________ Time: ________________

Surface Completion Condition: ____
____

Personnel: _________ Recorded on Video: ☐ Yes ☐ No Audio on Video: ☐ Yes ☐ No

Casing Material: ____________________________________ Diameter of Well: _____________

Pass #1 Camera Angle: ☐ 0˚ ☐ 45˚ ☐ 90˚ Measuring Point: ________________

Observations: ____
____
____
____

Pass #2 Camera Angle: ☐ 0˚ ☐ 45˚ ☐ 90˚ Measuring Point: ________________

Observations: ____
____
____
____

Pass #3 Camera Angle: ☐ 0˚ ☐ 45˚ ☐ 90˚ Measuring Point: ________________

Observations: ____
____
____
____

Measurement with weighted Tape Measure: ____

Additional Notes: ____
____

Recommended Action: ____
____

Optional Drawing:

Well Development Field Data Sheet

Well ________________________________ Site ____

Development Personnel ___________________________________ Pump Type __________________

Casing Diameter ________________ DTW ______________ DTB ___________________

Well Volume = _________________ gal/ft* x (DTB - DTW) ___________ = __________ gal

x3 = __________ gal

x10 = __________ gal

Date	**Time**	**WL (ft)**	**Flow Rate**	**Temp**	**pH**	**△pH (units)**	**Cond.**	**△Cond. (%)**	**Total Volume**	**Remarks & Clarity**

*gal/ft: 1" = 0.041; 1.5" = 0.092; 2" = 0.163; 3" = 0.367; 4" = 0.65; 6" = 1.47; 8" = 2.61

or

gal/ft calculation: $(1/4d^2\pi h) \times 7.4805$ = ________ gal/ft (h = 1; d = diameter in feet)

Revised 8/25/95

Groundwater Sciences Corporation

Sampling and Analysis Request Form

Page ________ of ______

Date ________________

General

Project No.: ________________ Project Name: ______________________________ Client Contact/Phone: __________________________

Start Date: ________________ End Date: ________________________ Sample Transportation: __________________________________

COC Instructions: ____

____

Results to: ________________________ Copies to: ________________________________ Lab Invoice to: ________________________

Health and Safety

Materials expected and concentration: ____

Ambient Monitoring: Y/N Monitoring method: ____

Special conditions: ____

Action level: ________________________ Protection required: ____

Sampling and Analysis

Location	Media	Purge	Contain.	Analyses	TAT	Lab

QA/QC Samples

Location	Media Type	Sample Type	Analyses	TAT	Lab

Distribution RS ____ Sampler ____

Lab Director/Manager ______________________________ Sampler ____

August 1996

Calibration Record

Instrument: ____________________

Serial #: ______________

			pH		Conductivity		Calibrated By
Date	Time	Temp.	Initial	Corrected	Initial	Corrected	

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GROUNDWATER SCIENCES CORPORATION

Groundwater Field Data Sheet

Low-Flow Groundwater Purging and Sampling

General Information

Site/Location: ____________________
Project Number: ____________________
Sample Location/Well ID: ____________________
Surface Completion: ____________________
Physical Condition: ____________________

Sampling Information

Date: ____________________
Personnel: ____________________
Sample Time: ____________________
Sample Rate: ____________________
Laboratory: ____________________
Analyses: ____________________

Purging Information

Date: ____________________
Personnel: ____________________
Total Depth: ____________________
SWL: ____________________
Well Diameter: ____________________
Well Volume: ____________________
Pump Type: ____________________
Pump Depth: ____________________
Start Time: ____________________
Stop Time: ____________________
Purge Rate: ____________________

Time	pH (S.U.)	SC (mS/cm)	Turb (NTU)	Salinity	DO (mg/L)	Temp (deg C)	ORP (mV)	Depth to H_2O (ft)	NOTES
NA	+/- 0.1 Unit	+/- 3%	+/- 10% or <10 NTU		+/- 10%	+/- 1 deg C	+/- 10 mV	< 0.3 ft -- Adj Purge Rate As Necessary	NA

GROUNDWATER SCIENCES CORPORATION

Sampling Field Data Sheet

GENERAL INFORMATION

Sample Location/Well ID:______________________________ Site:____

Manhole/Standpipe/Other (circle one) If Other Explain: ____

Physical Well/Location Condition: ____

PURGING

Date: __________ Personnel: ____________ Air Temp: _______ Skies: ________ Wnd Spd/Drctn: _________________

TD: ________ SWL: ________ TD – SWL ________ Required Purge Vol: (TD – SWL x C F (below)) _____________ (gal)

Method: __________________ Start Time: __________ Stop Time: ___________ Volume Purged: _____________ (gal)

Water Level at End of Purge (WLEP): _______________ Total Purge Time: ____________ (minutes)

Water Level Required for 90% Recovery: TD - [(TD - SWL) x 0.90] = __________________

Conversion Factors (well diameter – gallons per foot of water): *(¼ d^2 π) x 7.4805 = gal/ft (d = well diameter in feet)*

1 Vol: **½” – 0.01; ¾” – 0.023; 1” – 0.041; 1 ¼” – 0.063; 1 ½” – 0.092; 2” – 0.163; 3” – 0.367; 4” – 0.653; 6” – 1.47; 8” – 2.61; 10” – 4.08; 12” – 5.88**
3 Vol: **½” – 0.03; ¾” – 0.069; 1” – 0.123; 1 ¼” – 0.189; 1 ½” – 0.276; 2” – 0.489; 3” – 1.101; 4” – 1.959; 6” – 4.41; 8” – 7.83; 10” – 12.24; 12” – 17.64**

SAMPLING

Sample ID:												

Sample Type: Groundwater
(circle one) Surface water
Other _____________

Date: __________ Personnel: ____________ Air Temp: _______ Skies: ________ Wnd Spd/Drctn: ________________

WL Recovery (WL/time): _______/________; _______/________; _______/________; _______/________; ______/________

Sampled Depth Interval: ________ to ________ feet (gs or toc) Sampling Method: _________________________________

Field Data (in well or in line): START TIME: ____________ STOP TIME: ___________

Depth	*pH*	*Sp. Cond.*	*Temp*	*DO*	*Eh*	*Clarity*

Sampler’s Signature: _____________________________________ **Was this sample collected w/in 2 hrs of end of purge? Yes No**

LABORATORY INFORMATION

Laboratory: _____________________________ Turnaround Time (TAT): ____________ Number of Containers: _______

Date Shipped or Delivered: ____________ Method of Delivery to Laboratory: _____________________________________

Analyses Requested: ____

____

ADDITIONAL NOTES

,,,,,,,,

Field Sampling Data Sheet

GENERAL INFORMATION:

Well No: _____________ **Date:** ______/______/_______ **Personnel:** ___________

PURGING:

Reference Depth to Bottom (DTBr): ft.	**Start:**	**Stop:**
Measured Depth to Bottom (DTBm): ft.	*Note: Use Reference Depth to Bottom for calculations*	
Depth to Water (DTW): ft.	**Well Yields:** ☐ *Yes* ☐ *No*	
Target Volume: gal.	**Water Contained:** ☐ *Yes* ☐ *No*	
Actual Volume: gal.	**DTW After Purge: ft.**	

PID:	***Background:***	***Purging:***	☐ *Not Applicable*

Purge Method	***Rate***	***Equipment ID***
☐ Bailer	______________________	______________________
☐ Peristaltic Pump	______________________	______________________
☐ Well Wizard	______________________	______________________
☐ American Sigma	______________________	______________________
☐ Bladder Pump	______________________	______________________
☐ Submersible	______________________	______________________

SAMPLING:

Sample ID:

Sample Time: Start: ___________ Stop: ___________

Duplicate ID:

Sample Method:

☐ Bailer
☐ American Sigma
☐ Well Wizard
☐ Tap

COMMENTS:

Signature: __________________________ Date: _______ QA/QC Review: _______ Date: ________

GROUNDWATER SCIENCES CORPORATION

Soil Sampling Field Data Sheet

GENERAL INFORMATION

Sample Location / ID:______________________________ Site:____

Boring/Test Pit/Other (circle one) If Other Explain: ____

SAMPLING

Sample ID:

Sample Method: (circle one)
Geoprobe
Split Spoon
Backhoe/Excavator
Other ___________

Date: __________ Personnel: ____________ Air Temp: _______ Skies: ________ Wnd Spd/Drctn: _______________

Sampled Depth Interval: ______ to ______ feet (bgs) START TIME: _____________ STOP TIME: _____________

PID Scan: ____________ ppm Headspace YES / NO (circle one) Sample Type: GRAB / COMPOSITE (circle one)

LABORATORY INFORMATION

Laboratory: _____________________________ Turnaround Time (TAT): ____________ Number of Containers: _______

Date Shipped or Delivered: ____________ Method of Delivery to Laboratory: _____________________________________

Analyses Requested: ____

____

GENERAL INFORMATION

Sample Location / ID:______________________________ Site:____

Boring/Test Pit/Other (circle one) If Other Explain: ____

SAMPLING

Sample ID:

Sample Method: (circle one)
Geoprobe
Split Spoon
Backhoe/Excavator
Other ___________

Date: __________ Personnel: ____________ Air Temp: _______ Skies: ________ Wnd Spd/Drctn: _______________

Sampled Depth Interval: ______ to ______ feet (bgs) START TIME: _____________ STOP TIME: _____________

PID Scan: ____________ ppm Headspace YES / NO (circle one) Sample Type: GRAB / COMPOSITE (circle one)

LABORATORY INFORMATION

Laboratory: _____________________________ Turnaround Time (TAT): ____________ Number of Containers: _______

Date Shipped or Delivered: ____________ Method of Delivery to Laboratory: _____________________________________

Analyses Requested: ____

____

ADDITIONAL NOTES

Groundwater Sciences Corporation
Field Data Table

Site: ____________________ **Project:** ________________ **Method:** ________________ **Sampler:** ________________

Well	Sampling Date	Sampling Time	pH	Specific Conductivity	Temperature	Interval

Physical Well Inventory

Needs Repair: Yes No

Date repair was completed: _______________

Well #: ____________________

Date: ____________________

Evaluation:

☐ Manhole ☐ Standpipe ☐ Other _________________________

Is the ID # of the well visible	yes	no	n/a
Is the Royer or Cover functional	yes	no	n/a
If Manhole, is there an expanding plug	yes	no	n/a
Is the lock functional	yes	no	n/a
Does the well have a concrete apron	yes	no	n/a
Is the surface completion stable	yes	no	n/a
Is the well paint in good condition	yes	no	n/a
Verify well location using site print	yes	no	n/a
Does well location agree with print	yes	no	n/a
Is the survey mark visible	yes	no	n/a

Measurements:

☐ survey mark

☐ top of casing

☐ other ___________

Static Water Level: ______________

Depth to Bottom: _______________

Diameter of well: ________________

Standpipe measurement above grade: ______________________

Manhole measurement below grade: _______________________

Location of Well: ____

Comments: ____

Well Inventory Performed By (Name): ____

Well Decommissioning Form

General Information

Well No.:	Location:	Northing	Easting
Date: / /	Personnel:		
Historical DTB: ft	Current DTB: ft	Depth to Water: ft ☐ Dry	
Measuring point location: ☐ TOC		☐ Standpipe	☐ Manhole
Verify well ID with site map: ☐ Yes ☐ No		Well diameter: inches	

Abandonment Information

Abandonment method (check all that apply): ☐ Pull casing ☐ Grout ☐ Perforate casing	
Materials: ☐ Bentonite: ________% ☐ Portland Cement: ________%	Brand:
Time started:	Time completed:
Displaced water contained: ☐ Yes ☐ No ☐ Not applicable	
Casing broke off: ☐ Yes ☐ No ☐ Not applicable	
Casing materials: ☐ PVC ☐ Stainless Steel ☐ Steel ☐ Other	
Well bore plugged to a depth of ft ☐ Bottom of well	
Approximate length of casing remaining in the ground: ft ☐ Not applicable	
Comments:	

Surface Completion

☐ Standpipe removed ☐ Manhole removed ☐ Apron removed	
Excavation depth: ft	Excavation fill materials:

Additional Notes

EnviroTest Laboratories Inc.

CHAIN OF CUSTODY

315 Fullerton Avenue
Newburgh, NY 12550
TEL (845) 562-0890
FAX (845) 562-0841

CUSTOMER NAME

ADDRESS

CITY, STATE, ZIP

NAME OF CONTACT PHONE NO.

PROJECT LOCATION

PROJECT NUMBER / PO NO.

REPORT TYPE

STANDARD ☐ ISRA ☐
NJ REG ☐
NYASP A ☐ B ☐ CLP ☐
OTHER ____________

TURNAROUND

☐ NORMAL ____________
☐ QUICK ____________
☐ VERBAL ____________

REPORT # (Lab Use Only)

SAMPLE TEMP. ____________ C
SAMPLE REC'D ON ICE Y_____ N_____
ph CHECK Y_____ N_____
CHLORINE (RESIDUAL) Y_____ N_____
REVIEWED BY: ____________

NY PUBLIC WATER SUPPLIES

SOURCE ID ___ ___ ___
ELRP TYPE ___ ___ ___
FEDERAL ID ___ ___ ___ ___ ___ ___ ___ ___

Matrix

DW = DRINKING WATER S = SOIL O = OIL
WW = WASTE WATER SL = SLUDGE GW = GROUND WATER

NOTE: SAMPLE TEMPERATURE UPON RECEIPT MUST BE 4° ± 2°C.

ETL #	SAMPLING DATE	SAMPLING TIME AM PM	COMP	GRAB	MATRIX	CLIENT I.D.	Total Number of Containers	40ml Glass HCL	Liter Amber HCL	250ml Amber Sulfuric	Liter Amber Organic Washed	250ml Plastic Nitric Acid	250ml Plastic Sodium Hydroxide	Liter Plastic	Liter Plastic Sulfuric Acid	250ml Plastic	125ml Plastic Sterile	8 oz. Soil	2 oz. Qorpak	250ml Plastic NAOH / ZN ACC	ANALYSIS REQUESTED
LAB USE ONLY																					

SAMPLES SUBMITTED FOR ANALYSIS WILL BE SUBJECT TO THE ETL TERMS AND CONDITIONS OF SALE UNLESS ALTERNATE TERMS ARE AGREED IN WRITING.

RELINQUISHED BY	COMPANY	DATE	TIME	RECEIVED BY	COMPANY	DATE	TIME
SAMPLED BY	COMPANY	DATE	TIME	RECEIVED BY	COMPANY	DATE	TIME
RELINQUISHED BY	COMPANY	DATE	TIME	RECEIVED BY	COMPANY	DATE	TIME

COMMENTS ____________

NYSDOH 10142 NJDEP NY015 CTDOPH PH-0554 EPA NY00049

TestAmerica Burlington
30 Community Drive, Suite 11
South Burlington, VT 05403
Phone:(802)660-1990

Chain of Custody Record

TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING

Client Information	Sampler:	Lab PM:	Carrier Tracking No(s):	COC No:
Client Contact:	Phone:	E-Mail:		Page:
Company:		**Analysis Requested**		Job #:
Address:	**Due Date Requested:**			**Preservation Codes:**
City:	**TAT Requested (days):**			
State, Zip:				
Phone:	PO #:			
Email:	WO #:			
Project Name:	Project #:			
Site:	SSOW#:			**Other:**

Preservation Codes:

- A - HCL
- B - NaOH
- C - Zn Acetate
- D - Nitric Acid
- E - NaHSO4
- F - MeOH
- G - Amchlor
- H - Ascorbic Acid
- I - Ice
- J - DI Water
- K - EDTA
- L - EDA
- M - Hexane
- N - None
- O - AsNaO2
- P - Na2O4S
- Q - Na2SO3
- R - Na2S2SO3
- S - H2SO4
- T - TSP Dodecahydrate
- U - Acetone
- V - MCAA
- W - ph 4-5
- Z - other (specify)

Sample Identification - Client ID	Sample Date	Sample Time	Sample Type (C=comp, G=grab)	Matrix (W=water, S=solid, O=waste/oil, BT=Tissue, A=Air)	Field Filtered Sample (Yes or No)	Perform MS/MSD (Yes or No)														Total Number of containers	Special Instructions/Note:
			Preservation Code:																		

Possible Hazard Identification
☐ *Non-Hazard* ☐ *Flammable* ☐ *Skin Irritant* ☐ *Poison B* ☐ *Unknown* ☐ *Radiological*

Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)
☐ *Return To Client* ☐ *Disposal By Lab* ☐ *Archive For ________ Months*

Deliverable Requested: I, II, III, IV, Other (specify)

Special Instructions/QC Requirements:

Relinquished by:	Date/Time:	Company	Received by:	Date/Time:	Company
Relinquished by:	Date/Time:	Company	Received by:	Date/Time:	Company
Relinquished by:	Date/Time:	Company	Received by:	Date/Time:	Company

Custody Seals Intact: ∆ Yes ∆ No	Custody Seal No.:	Cooler Temperature(s) °C and Other Remarks:

U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION II

GROUND WATER SAMPLING PROCEDURE
LOW STRESS (Low Flow) PURGING AND SAMPLING

I. SCOPE & APPLICATION

This Low Stress (or Low-Flow) Purging and Sampling Procedure is the EPA Region II standard method for collecting low stress (low flow) ground water samples from monitoring wells. Low stress Purging and Sampling results in collection of ground water samples from monitoring wells that are representative of ground water conditions in the geological formation. This is accomplished by minimizing stress on the geological formation and minimizing disturbance of sediment that has collected in the well. The procedure applies to monitoring wells that have an inner casing with a diameter of 2.0 inches or greater, and maximum screened intervals of ten feet unless multiple intervals are sampled. The procedure is appropriate for collection of ground water samples that will be analyzed for volatile and semi-volatile organic compounds (VOCs and SVOCs), pesticides, polychlorinated biphenyls (PCBs), metals, and microbiological and other contaminants in association with all EPA programs.

This procedure does not address the collection of light or dense non-aqueous phase liquids (LNAPL or DNAPL) samples, and should be used for aqueous samples only. For sampling NAPLs, the reader is referred to the following EPA publications: DNAPL Site Evaluation (Cohen & Mercer, 1993) and the RCRA Ground-Water Monitoring: Draft Technical Guidance (EPA/530-R-93-001), and references therein.

II. METHOD SUMMARY

The purpose of the low stress purging and sampling procedure is to collect ground water samples from monitoring wells that are representative of ground water conditions in the geological formation. This is accomplished by setting the intake velocity of the sampling pump to a flow rate that limits drawdown inside the well casing.

Sampling at the prescribed (low) flow rate has three primary benefits. First, it minimizes disturbance of sediment in the bottom of the well, thereby producing a sample with low turbidity (i.e., low concentration of suspended particles). Typically, this saves time and analytical costs by eliminating the need for collecting and analyzing an additional filtered sample from the same well. Second, this procedure minimizes aeration of the ground water during sample collection, which improves the sample quality for VOC analysis. Third, in most cases the procedure significantly reduces the volume of ground water purged from a well and the costs associated with its proper treatment and disposal.

III. ADDRESSING POTENTIAL PROBLEMS

Problems that may be encountered using this technique include a) difficulty in sampling wells with insufficient yield; b) failure of one or more key indicator parameters to stabilize; c) cascading of water and/or formation of air bubbles in the tubing; and d) cross-contamination between wells.

Insufficient Yield

Wells with insufficient yield (i.e., low recharge rate of the well) may dewater during purging. Care should be taken to avoid loss of pressure in the tubing line due to dewatering of the well below the level of the pump's intake. Purging should be interrupted before the water level in the well drops below the top of the pump, as this may induce cascading of the sand pack. Pumping the well dry should therefore be avoided to the extent possible in all cases. Sampling should commence as soon as the volume in the well has recovered sufficiently to allow collection of samples. Alternatively, ground water samples may be obtained with techniques designed for the unsaturated zone, such as lysimeters.

Failure to Stabilize Key Indicator Parameters

If one or more key indicator parameters fails to stabilize after 4 hours, one of three options should be considered: a) continue purging in an attempt to achieve stabilization; b) discontinue purging, do not collect samples, and document attempts to reach stabilization in the log book; c) discontinue purging, collect samples, and document attempts to reach stabilization in the log book; or d) Secure the well, purge and collect samples the next day (preferred). The key indicator parameter for samples to be analyzed for VOCs is dissolved oxygen. The key indicator parameter for all other samples is turbidity.

Cascading

To prevent cascading and/or air bubble formation in the tubing, care should be taken to ensure that the flow rate is sufficient to maintain pump suction. Minimize the length and diameter of tubing (i.e., 1/4 or 3/8 inch ID) to ensure that the tubing remains filled with ground water during sampling.

Cross-Contamination

To prevent cross-contamination between wells, it is strongly recommended that dedicated, in-place pumps be used. As an alternative, the potential for cross-contamination can be reduced by performing the more thorough "daily" decontamination procedures between sampling of each well in addition to the start of each sampling day (see Section VII, below).

Equipment Failure

Adequate equipment should be on-hand so that equipment failures do not adversely impact sampling activities.

IV. PLANNING DOCUMENTATION AND EQUIPMENT

- Approved site-specific Field Sampling Plan/Quality Assurance Project Plan (QAPP). This plan must specify the type of pump and other equipment to be used. The QAPP must also specify the depth to which the pump intake should be lowered in each well. Generally, the target depth will correspond to the mid-point of the most permeable zone in the screened interval. Borehole geologic and geophysical logs can be used to help select the most permeable zone. However, in some cases, other criteria may be used to select the target depth for the pump intake. In all cases, the target depth must be approved by the EPA hydrogeologist or EPA project scientist.

- Well construction data, location map, field data from last sampling event.

- Polyethylene sheeting.

- Flame Ionization Detector (FID) and Photo Ionization Detector (PID).

- Adjustable rate, positive displacement ground water sampling pump (e.g., centrifugal or bladder pumps constructed of stainless steel or Teflon). A peristaltic pump may only be used for inorganic sample collection.

- Interface probe or equivalent device for determining the presence or absence of NAPL.

- Teflon or Teflon-lined polyethylene tubing to collect samples for organic analysis. Teflon or Teflon-lined polyethylene, PVC, Tygon or polyethylene tubing to collect samples for inorganic analysis. Sufficient tubing of the appropriate material must be available so that each well has dedicated tubing.

- Water level measuring device, minimum 0.01 foot accuracy, (electronic preferred for tracking water level drawdown during all pumping operations).

- Flow measurement supplies (e.g., graduated cylinder and stop watch or in-line flow meter).

- Power source (generator, nitrogen tank, etc.).
- Monitoring instruments for indicator parameters. Eh and dissolved oxygen must be monitored in-line using an instrument with a continuous readout display. Specific conductance, pH, and temperature may be monitored either in-line or using separate probes. A nephalometer is used to measure turbidity.

- Decontamination supplies (see Section VII, below).

- Logbook (see Section VIII, below).

- Sample bottles.

- Sample preservation supplies (as required by the analytical methods).

- Sample tags or labels, chain of custody.

V. SAMPLING PROCEDURES

Pre-Sampling Activities

1. Start at the well known or believed to have the least contaminated ground water and proceed systematically to the well with the most contaminated ground water. Check the well, the lock, and the locking cap for damage or evidence of tampering. Record observations.

2. Lay out sheet of polyethylene for placement of monitoring and sampling equipment.

3. Measure VOCs at the rim of the unopened well with a PID and FID instrument and record the reading in the field log book.

4. Remove well cap.

5. Measure VOCs at the rim of the opened well with a PID and an FID instrument and record the reading in the field log book.

6. If the well casing does not have a reference point (usually a V-cut or indelible mark in the well casing), make one. Note that the reference point should be surveyed for correction of ground water elevations to the mean geodesic datum (MSL).

7. Measure and record the depth to water (to 0.01 ft) in all wells to be sampled prior to purging. Care should be taken to minimize disturbance in the water column and dislodging of any particulate matter attached to the sides or settled at the bottom of the well.

8. If desired, measure and record the depth of any NAPLs using an interface probe. Care should be taken to minimize disturbance of any sediment that has accumulated at the bottom of the well. Record the observations in the log book. If LNAPLs and/or DNAPLs are detected, install the pump at this time, as described in step 9, below. Allow the well to sit for several days between the measurement or sampling of any DNAPLs and the low-stress purging and sampling of the ground water.

<u>Sampling Procedures</u>

9. Install Pump: Slowly lower the pump, safety cable, tubing and electrical lines into the well to the depth specified for that well in the EPA-approved QAPP or a depth otherwise approved by the EPA hydrogeologist or EPA project scientist. The pump intake must be kept at least two (2) feet above the bottom of the well to prevent disturbance and resuspension of any sediment or NAPL present in the bottom of the well. Record the depth to which the pump is lowered.

10. Measure Water Level: Before starting the pump, measure the water level again with the pump in the well. Leave the water level measuring device in the well.

11. Purge Well: Start pumping the well at 200 to 500 milliliters per minute (ml/min). The water level should be monitored approximately every five minutes. Ideally, a steady flow rate should be maintained that results in a stabilized water

level (drawdown of 0.3 ft or less). Pumping rates should, if needed, be reduced to the minimum capabilities of the pump to ensure stabilization of the water level. As noted above, care should be taken to maintain pump suction and to avoid entrainment of air in the tubing. Record each adjustment made to the pumping rate and the water level measured immediately after each adjustment.

12. Monitor Indicator Parameters: During purging of the well, monitor and record the field indicator parameters (turbidity, temperature, specific conductance, pH, Eh, and DO) approximately every five minutes. The well is considered stabilized and ready for sample collection when the indicator parameters have stabilized for three consecutive readings as follows (Puls and Barcelona, 1996):

    ±0.1 for pH
    ±3% for specific conductance (conductivity)
    ±10 mv for redox potential
    ±10% for DO and turbidity

    Dissolved oxygen and turbidity usually require the longest time to achieve stabilization. The pump must not be removed from the well between purging and sampling.

13. Collect Samples: Collect samples at a flow rate between 100 and 250 ml/min and such that drawdown of the water level within the well does not exceed the maximum allowable drawdown of 0.3 ft. VOC samples must be collected first and directly into sample containers. All sample containers should be filled with minimal turbulence by allowing the ground water to flow from the tubing gently down the inside of the container.

    Ground water samples to be analyzed for volatile organic compounds (VOCs) require pH adjustment. The appropriate EPA Program Guidance should be consulted to determine whether pH adjustment is necessary. If pH adjustment is necessary for VOC sample preservation, the amount of acid to be added to each sample vial prior to sampling should be determined, drop by drop, on a separate and equal volume of water (e.g., 40 ml). Ground water purged from the well prior to sampling can be used for this purpose.

14. Remove Pump and Tubing: After collection of the samples, the tubing, unless permanently installed, must be properly discarded or dedicated to the well for resampling by hanging the tubing inside the well.

15. Measure and record well depth.

16. Close and lock the well.

VI. FIELD QUALITY CONTROL SAMPLES

Quality control samples must be collected to determine if sample collection and handling procedures have adversely affected the quality of the ground water samples. The appropriate EPA Program Guidance should be consulted in preparing the field QC sample requirements of the site-specific QAPP.

All field quality control samples must be prepared exactly as regular investigation samples with regard to sample volume, containers, and preservation. The following quality control samples should be collected during the sampling event:

- Field duplicates
- Trip blanks for VOCs only
- Equipment blank (not necessary if equipment is dedicated to the well)

As noted above, ground water samples should be collected systematically from wells with the lowest level of contamination through to wells with highest level of contamination. The equipment blank should be collected after sampling from the most contaminated well.

VII. DECONTAMINATION

Non-disposable sampling equipment, including the pump and support cable and electrical wires which contact the sample, must be decontaminated thoroughly each day before use ("daily decon") and after each well is sampled ("between-well decon"). Dedicated, in-place pumps and tubing must be thoroughly decontaminated using "daily decon" procedures (see #17, below) prior to their initial use. For centrifugal pumps, it is strongly recommended that non-disposable sampling equipment, including the pump and support cable and electrical wires in contact with the sample, be decontaminated thoroughly each day before use ("daily decon").

EPA's field experience indicates that the life of centrifugal pumps may be extended by removing entrained grit. This also permits inspection and replacement of the cooling water in centrifugal pumps. All non-dedicated sampling equipment (pumps, tubing, etc.) must be decontaminated after each well is sampled ("between-well decon," see #18 below).

17. **Daily Decon**

A) Pre-rinse: Operate pump in a deep basin containing 8 to 10 gallons of potable water for 5 minutes and flush other equipment with potable water for 5 minutes.

B) Wash: Operate pump in a deep basin containing 8 to 10 gallons of a non-phosphate detergent solution, such as Alconox, for 5 minutes and flush other equipment with fresh detergent solution for 5 minutes. Use the detergent sparingly.

C) Rinse: Operate pump in a deep basin of potable water for 5 minutes and flush other equipment with potable water for 5 minutes.

D) Disassemble pump.

E) Wash pump parts: Place the disassembled parts of the pump into a deep basin containing 8 to 10 gallons of non-phosphate detergent solution. Scrub all pump parts with a test tube brush.

F) Rinse pump parts with potable water.

G) Rinse the following pump parts with distilled/ deionized water: inlet screen, the shaft, the suction interconnector, the motor lead assembly, and the stator housing.

H) Place impeller assembly in a large glass beaker and rinse with 1% nitric acid (HNO_3).

I) Rinse impeller assembly with potable water.

J) Place impeller assembly in a large glass bleaker and rinse with isopropanol.

K) Rinse impeller assembly with distilled/deionized water.

18. **Between-Well Decon**

A) Pre-rinse: Operate pump in a deep basin containing 8 to 10 gallons of potable water for 5 minutes and flush other equipment with potable water for 5 minutes.
B) Wash: Operate pump in a deep basin containing 8 to 10 gallons of a non-phosphate detergent solution, such as Alconox, for 5

minutes and flush other equipment with fresh detergent solution for 5 minutes. Use the detergent sparingly.

C) Rinse: Operate pump in a deep basin of potable water for 5 minutes and flush other equipment with potable water for 5 minutes.

D) Final Rinse: Operate pump in a deep basin of distilled/deionized water to pump out 1 to 2 gallons of this final rinse water.

VIII. FIELD LOG BOOK

A field log book must be kept each time ground water monitoring activities are conducted in the field. The field log book should document the following:

- Well identification number and physical condition.
- Well depth, and measurement technique.
- Static water level depth, date, time, and measurement technique.
- Presence and thickness of immiscible liquid layers and detection method.
- Collection method for immiscible liquid layers.
- Pumping rate, drawdown, indicator parameters values, and clock time, at three to five minute intervals; calculate or measure total volume pumped.
- Well sampling sequence and time of sample collection.
- Types of sample bottles used and sample identification numbers.
- Preservatives used.
- Parameters requested for analysis.
- Field observations of sampling event.
- Name of sample collector(s).
- Weather conditions.
- QA/QC data for field instruments.

IX. REFERENCES

Cohen, R.M. and J.W. Mercer, 1993, DNAPL Site Evaluation, C.K. Smoley Press, Boca Raton, Florida.

Puls, R.W. and M.J. Barcelona, 1996, Low-Flow (Minimal Drawdown) Ground-water Sampling Procedures, EPA/540/S-95/504.

U.S. EPA, 1993, RCRA Ground-Water Monitoring: Draft Technical Guidance, EPA/530-R-93-001.

U.S. EPA Region II, 1989, CERCLA Quality Assurance Manual.

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505-455-1300, www.flut.com

Use of Pressure Transducers with Water FLUTe System

Use of Pressure Transducers with Water FLUTe System

Purpose

This guide explains where the pressure transducer is located in the Water FLUTe system and how the formation head is measured at each port both manually and with the pressure transducer. The manual measurement is required to determine the precise depth of the pressure transducer in the borehole. Given the depth of the transducer, all future head measurements can be determined from the transducer measurements.

Geometry

The Water FLUTe multi level sampling system is shown in Fig. 1. The formation water flows from the formation into the spacer interstitial space and via the annular spacer into the port. The water is conducted from the port to the bottom of the hole and upward into the pump tube volume through the first check valve. The water from the port fills the pump tube to the level of the natural head in the formation.

When pressure transducers are part of the design, the pressure transducer is located just below the first check valve on the port to pump tube (Fig 2.). The pressure transducer measures the water pressure in the tube at the elevation of the transducer diaphragm shown in Fig. 2.

The water from the port also fills the sample tube though the second check valve. If the system has been pumped, the sample tube may also be filled to the surface.

Calibration of the pressure transducer

Since the pressure transducer measures the head in the port-to-pump tube which is open to the formation, the pressure measured is the head in the formation at the depth of the transducer diaphragm (Fig 2). If one knows the depth of the transducer below the ground surface, the water table depth below the surface can be calculated directly for that port (WT bgs = depth transducer - head measured by transducer).

Another simple means of measuring the water table depth is to tag the depth of the water in the pump tube (Fig. 2) if the water table is less than 200 ft. (For deeper water tables, contact FLUTe for a special tag line.) If one has measured the depth to the water in the pump tube, he can calculate the depth to the transducer (depth to transducer = WT Depth bgs+ head measured by transducer). Since the actual depth of the transducer is not precisely known when the liner is emplaced due to a variety of factors including the actual depth of the hole, the depth of the transducer is best determined from this manual measurement of the water table in the pump tube. The first check valve has a Teflon ball so as to minimize any perturbation to the equilibration of the water in the pump tube at the actual water table for that port.

However, because of the fact that the check valve will prevent the water flow out of the pump tube to the port, the water level in the pump tube can not follow a dropping water table in time. In order to obtain the correct current water table, the entire contents of the pump tube and sampling tube must be expelled to allow the pump tube to fill to the current water table level. Therefore, a gas pressure source should be used with the normal water sampling valves to expel all of the water from the system just as described for the purge procedure in the water sampling procedure (Fig. 3). The water sampling procedure is available from FLUTe.

It is important to remember that the pressure transducer is connected directly to the formation and is not measuring through any check valves. Therefore, the transducer follows the head changes in the formation. As the pump refills, the transducer will follow the last portion of the rising head in the pump when the flow velocity of the water in the pump is very low.

Procedure for calibration of the pressure transducer
To obtain the depth of the transducer in the hole, purge the pump of all water and let it equilibrate to a new water level equal to the water table in the formation. Measure the depth of the water table in the pump tube. This is the depth of the water table in the formation for that port (it may not be the water table measured in the open hole). Add the head measured in the pump tube to the head measured by the transducer. The sum is the depth of the transducer below the surface. For all future head measurements in the formation (water table depths below the surface), subtract the transducer head measurement from the transducer depth. This same procedure is used for each port. This will provide the depth to the water table for each port elevation in the formation. For absolute elevations, convert the depths below the surface to elevation values.

Once the depth of each transducer has been determined, it does not need to be remeasured. However, with time the transducer calibration may drift. The manual measurement of the water table allows the transducer effective depth to be determined as often as desired.

FLUTe provides pressure transducers for specified ports as a service to our customers for the retail price of the transducer and cable with appropriate fittings. The transducer calibration information is also provided by FLUTe as received from the manufacturer. The warranty of the transducer and associated hardware is the responsibility of the manufacturer. For information on the transducers, please contact the manufacturer.

For any questions about this procedure, call 888-33-32433.

Fig. 1 Water FLUTe Port and Pump System

(Single port system shown for clarity)

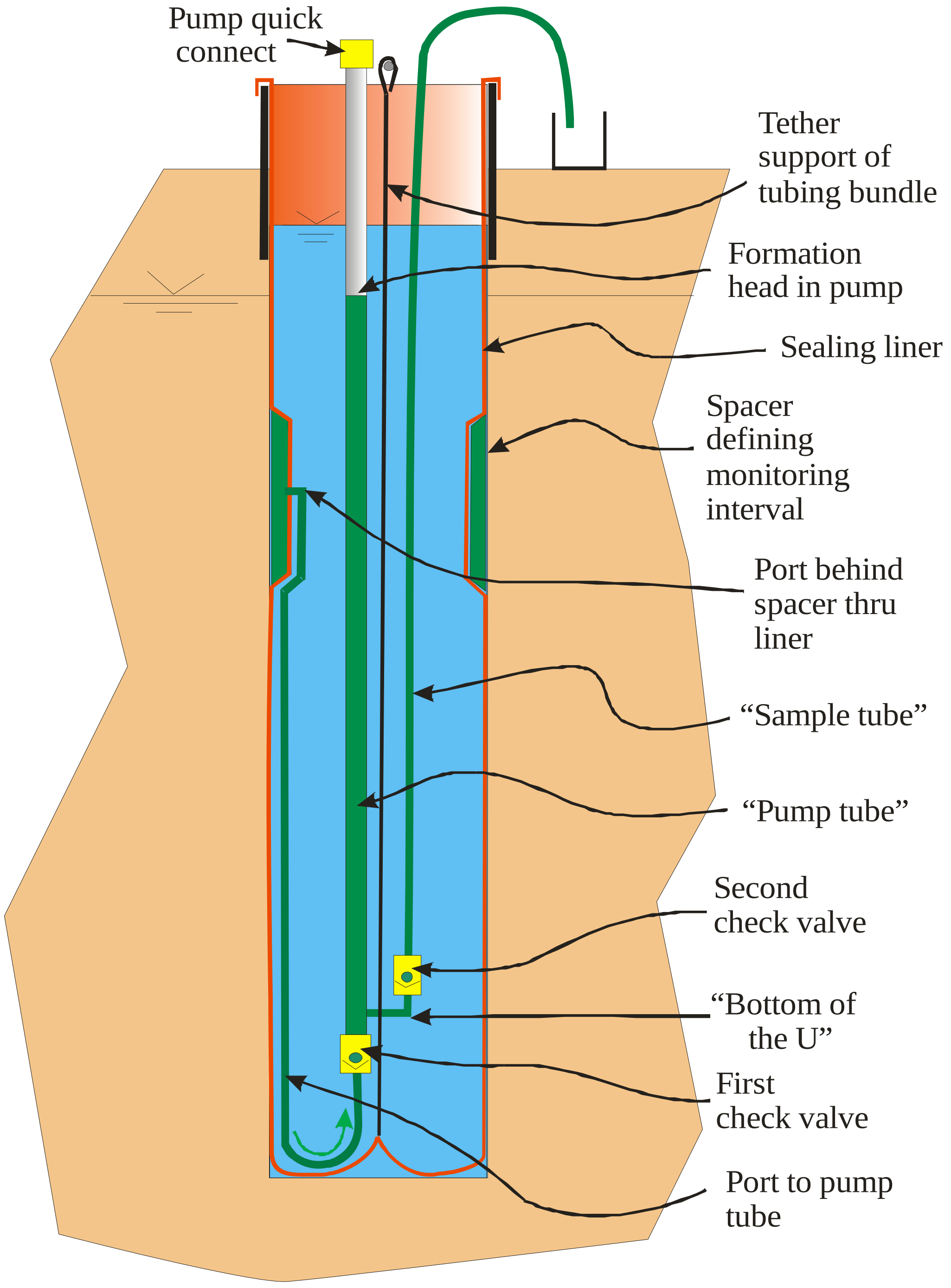


Fig. 2 Water FLUTe port/pump with Transducer

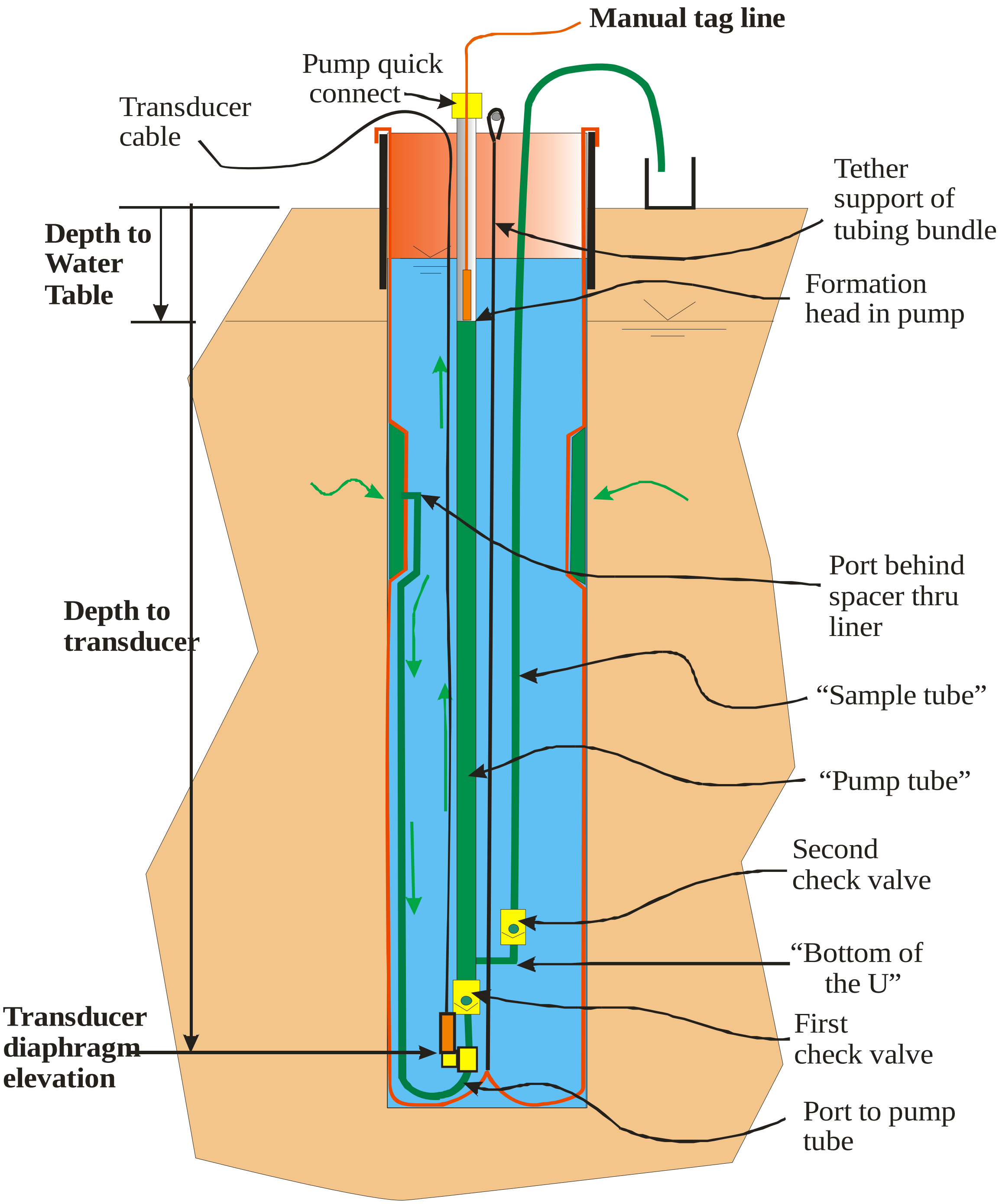
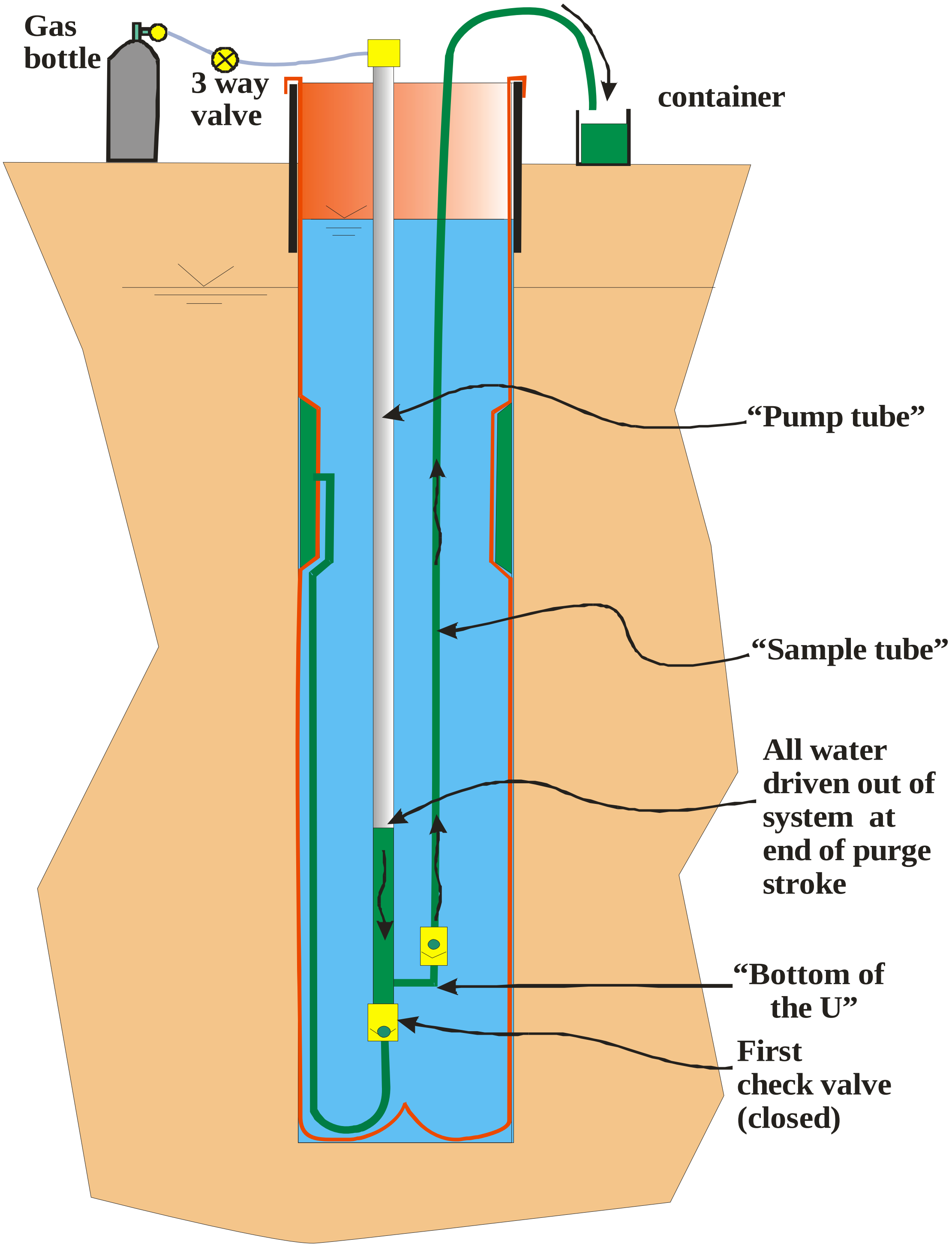


Fig. 3. Purge Pumping Procedure



FLUTe™ Flexible Liner Underground Technologies, Ltd. L.C.
For a medley of innovative designs
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505-455-1300, www.flut.com

Sampling guidelines for *Water FLUTe* systems

Rev. April, 2007

Water level in the liner.

The liner water level should be 10 ft above the highest formation water level to provide a good seal of the liner in the hole (5 ft minimum excess head). The formation water level can be measured via the “pump tube” for each port. The water level inside the liner should be tagged in the ½” id tube labeled “TAG” adjacent to the sampling tubes. If the water level inside the liner is measured in the liner, outside the Tag Tube, lower the weighted tag line very slowly to avoid damage to the liner. Water can be added to the liner by simply pouring water into the liner or through the TAG tube, whichever is easier. Do not fill the liner more than 10 ft above the highest formation water level. The water level in the liner should be checked prior to each sampling episode. (Beware that filling the liner with de-ionized water can give a false water level reading.)

Water flow

The water flow into the pumping system is shown in Fig. 1. Water flows from the formation through the spacer pore space, through the port tube, through the first check valve, and fills the “pump tube”. The “sample tube” is also filled at the same time. The water level rises in the pump tube to the water table for that port.

Setting up the gas pressure source

The water is pumped with gas pressure. The FLUTe pump design is such that there is very low risk of aeration of the sample. The gas source is usually a nitrogen bottle with a regulator for setting the prescribed driving pressure. The arrangement of the FLUTe gas drive system is shown in Fig. 2. The regulator is set to the proper gas pressure defined later by closing the three way valve to prevent gas flow out of the quick connect fitting. The pressure gauge on the FLUTe pump driver is much more sensitive than the regulator for setting the regulator pressure. The FLUTe pump driver must be securely connected to the regulator at the normal ¼” NPT connection on the regulator outlet.

The regulator is attached to the top fitting on the gas bottle (a special nitrogen regulator fitting connects to a nitrogen bottle). Turn the pressure regulator handle counter-clockwise until is moves freely (the no pressure position). Rotate the main valve on the regulator (nearer the bottle) clockwise to fully closed. Open the valve on the bottle (counter clockwise). The main bottle pressure gauge on the regulator will rise to the bottle pressure. Close the regulator valve (clockwise) until the pressure starts to rise on the pressure gauge on the FLUTe pump driver (three way valve closed with no flow out of the quick connect). Adjust the regulator to the desired pressure for purging, provided by FLUTe. Connect the quick connect to the top fitting of the pump tube (see Fig. 2). Open the three way valve to drive the water out of the pump.

Purging

Water is pumped from the tubing by applying the gas pressure to the interface at the static water level in the pump tube (Fig. 1 and 2). The water is driven down in the pump tube and up through the second check valve to the surface via the sample tube. By driving the water with a sufficient gas pressure (the "recommended purge pressure") to drive all of the water in the pump tube and the sample tube to the surface, the water in the pump tubing is nearly all expelled. The purge stroke is complete when gas is expelled from the sample tube following the water flow. The pressure in the system must then be vented (i.e., dropped to atmospheric by turning the three way valve to the vent position), to allow the pump tube to refill by flow via the port tube. The recharge flow from the port tube consists of the port tube water, the water in the pore space of the spacer, and water from the medium. Because of the relatively large volume in the pump tube, most of the recharge is from the medium. The recharge will take about as long as the first purge stroke. However, a low conductivity medium will require more time.

Purging the pump tube a second time will remove any of the water that has resided in the spacer and port tube volume. That is highly recommended, since the water resident in the tubing and spacer is probably not typical of the formation water. If the refill has been prompt, the second purge water volume will be similar to the first stroke. If in doubt, or if in a sedimentary formation or screened well, a third purge stroke is recommended to remove water that may have been in long contact with the liner or spacer.

Sampling

The sampling flow is best driven on the third (or fourth) cycle by a "recommended sampling pressure" which is less than that needed to drive gas through the bottom of the pump tube. The pressure recommended is that which will drive the water to near, but not out of, the bottom of the large tube. That recommended pressure, "the sampling pressure," is calculated in the spreadsheet provided with each system. The pressure regulator is set to the sample pressure, which is lower than the purge pressure. Opening the three way valve will now apply the sample pressure to the system causing flow from the sample tube.

The first flow of the sampling cycle sweeps along droplets of water left in the tubing from the purge cycle. That residual water is depleted of volatile components. Tests have shown that the first tube volume of the sample flow should be discarded as depleted in volatiles (the "discard volume" is also calculated in the spreadsheet). Thereafter, the samples can be collected from the sample tube outflow. The volume to be discarded is shown in the spreadsheet as "discard volume". The sample tube water flow rate will start fast, then slow, and finally stop. That occurs as the water column being driven approaches the applied pressure/head. The typical sampling pressure drives to within 25 ft. of the bottom of the pump tube (the U). The large buffer zone remaining in the pump tube assures against aeration of the sample.

This procedure should provide an ample sample of good quality drawn directly from the formation.

Caution: If the pumping system refills very slowly, there may not be sufficient water in the pump to fill the "sample tube" to the surface when the stroke is performed. In that case, there will be spitting of gas from the sample water and it will be followed by a flow of gas only. The sample water should never show "spitting" and the stroke should never end with gas flow from the sample tube. The proper sample flow will slow until it stops flowing. Should this evidence of insufficient recharge be observed, allow the pump to refill for a longer time and repeat the sample stroke. One can tag the water level in the large tube, as described in the head measurement procedure, to assure that the pumping system has been sufficient refilled.

Measuring the head in the system

The water level in the large tubes may not be the current water level. After sampling, if there is any leakage of the second check valve (sand in the tube, etc…) the water in the sample tube can backflow into the larger tube, adding to the water that fills the large tube during the recharge. Also, if the water level in the formation is dropping between head measurements, the water level in the pump tube will not follow the descent if the first check valve is a good seal. For these two reasons, and for the freezing concern below, it is best to <u>finish the sampling stroke by raising the pressure to the "purge pressure" value</u> to purge the pumping system of all water. Then upon refilling, the level is the current head for each port. If head measurements are made between sampling events, <u>each port's pumping system should be first be purged</u> to allow the tubing to refill to the current head value.

If the water might freeze in the sampling tubing near the surface, purge the entire volume of water from each sampling line, after sampling, before leaving it. Use the recommended purge pressure to remove all water, <u>not the sampling pressure</u>. **Each line should be blowing gas when the purge is complete.** If the lines were purged after sampling for head measurements, that is sufficient.

If the Water FLUTe uses PVDF tubing, the purge of the entire system after sampling should not be neglected, even if head measurements are not to be made. This removes the water column in the sampling tube. For deep water tables, the long term pressure of the standing water in the sampling tube might lead to excessive creep of the tubing which is susceptible to "cold flow", a characteristic of Teflon like materials. (This is not a concern except for very deep water tables (>300 ft).

In most cases, the performance of a final purge of the system after sampling is useful, even if not essential.

Simultaneous purge and sampling of all tubes

The FLUTe pumping system for each port is essentially identical in length, pump volume and elevation in the hole. This allows all ports to be purged and sampled simultaneously for a great saving in sampling time. The only difference for simultaneous sampling is that the pressure source must include a tube to each port fitting at the wellhead. FLUTe offers a manifold pump driver system at extra cost (the single port driver is provided with the Water FLUTe). The recommended purge and sample pressures are the same as used for single port sampling.

In some cases, the buoyancy of the sampling system is so great when emptied of water during the simultaneous purge that the tubing bundle can cause the liner to invert. The sampling volume spreadsheet provided with the liner notes whether the system can be purged simultaneously. This is only a problem for smaller hole diameters, many ports, and a small excess head in the liner. However, increasing the excess head in the liner to overcome the buoyancy of the tubing can be a hazard to the liner.

A short summary is provided as the following checklist:

Check List

1. Check/restore the water level in the liner.
2. Connect the gas driver source to the gas drive tube for the port.
3. Set the regulator to the recommended purge pressure.
4. Expel the tube water at the suggested purge pressure. Collect the purged water volume for verification of a good purge. Note the water flow time of the purge stroke.
5. Allow the tubing to refill. Repeat the purge. Collect the purge volume to assure the amount removed is at least the “port tube volume”. Was the refill long enough?
6. Purge a third time, if desired.
7. Allow the tubing to refill for the sample stroke.
8. Reduce the driving pressure to the “sampling pressure”. Apply the pressure and collect the first flow to measure the discard volume. Discard that water.
9. Reduce the pressure, if needed, to slow the flow and collect the samples.
10. Perform a final purge of the water out of the sampling lines by raising the driving pressure to the purge pressure value.

11. When the sampling system has refilled, tag the water level, if desired, for the current water table. If a port system is refilling very slowly, tag it at a later time.

See the spreadsheet provided with each *Water FLUTe* for the recommended purge and sampling pressures. Those are the pressures that can be used for a simultaneous purge of the several ports, but be sure that the buoyancy of the tubing will not lift the tubing, and the wellhead. The spreadsheet flags the condition where all ports should not be purged simultaneously. In most cases, several, to all, of the ports can be purged simultaneously.

Optimum sampling procedure:

Since it is often desirable to minimize the amount of time that the sample water resides in the pumping tubing, it is useful to note the actual time that is required for the recharge of the system. Since the fill rate slows dramatically for the last portion of the recharge, it is not necessary to wait for a complete refill. For most formations, the recharge is dominated by the tubing pressure drop. In that case, the time required for the purge stroke to be completed is about the same time required for the refill. (The exception is for a tight formation that recharges the tubing very slowly.) Hence the second purge can be started after waiting the same length of time as the first purge endured. If the second purge is of a similar volume (usually somewhat less) than the first purge volume, the refill time was long enough. After the same delay, the sampling stroke can be initiated. This timing of the strokes allows one to reduce the retention time in the pumping system. For very large sample volumes produced, the refill time can be shortened even more, as long as the sample volume is adequate after the discard of the first flow.

In some situations, the retention time is still too long. FLUTe can often increase the sample tube and port tube diameters for greater flow rates. However, the standard design is well matched for to a wide range of hole diameters, depths, and water table elevations. For very deep wells, the tubing may need to be of higher pressure capacity for the required driving pressures. For water table depths below 700 ft., this may be a concern. FLUTe initiated a design change from Nylon 11 to PVDF tubing in the Water FLUTe systems in 2002 to avoid any concern about tubing interaction with the sample water. However, the prescribed purge is sufficient for the use of Nylon tubing systems.

Questions: Call 888-333-2433 and ask for Carl Keller, or a field engineer.

Figure 1. Water FLUTe pump system

(Single port system shown for clarity)

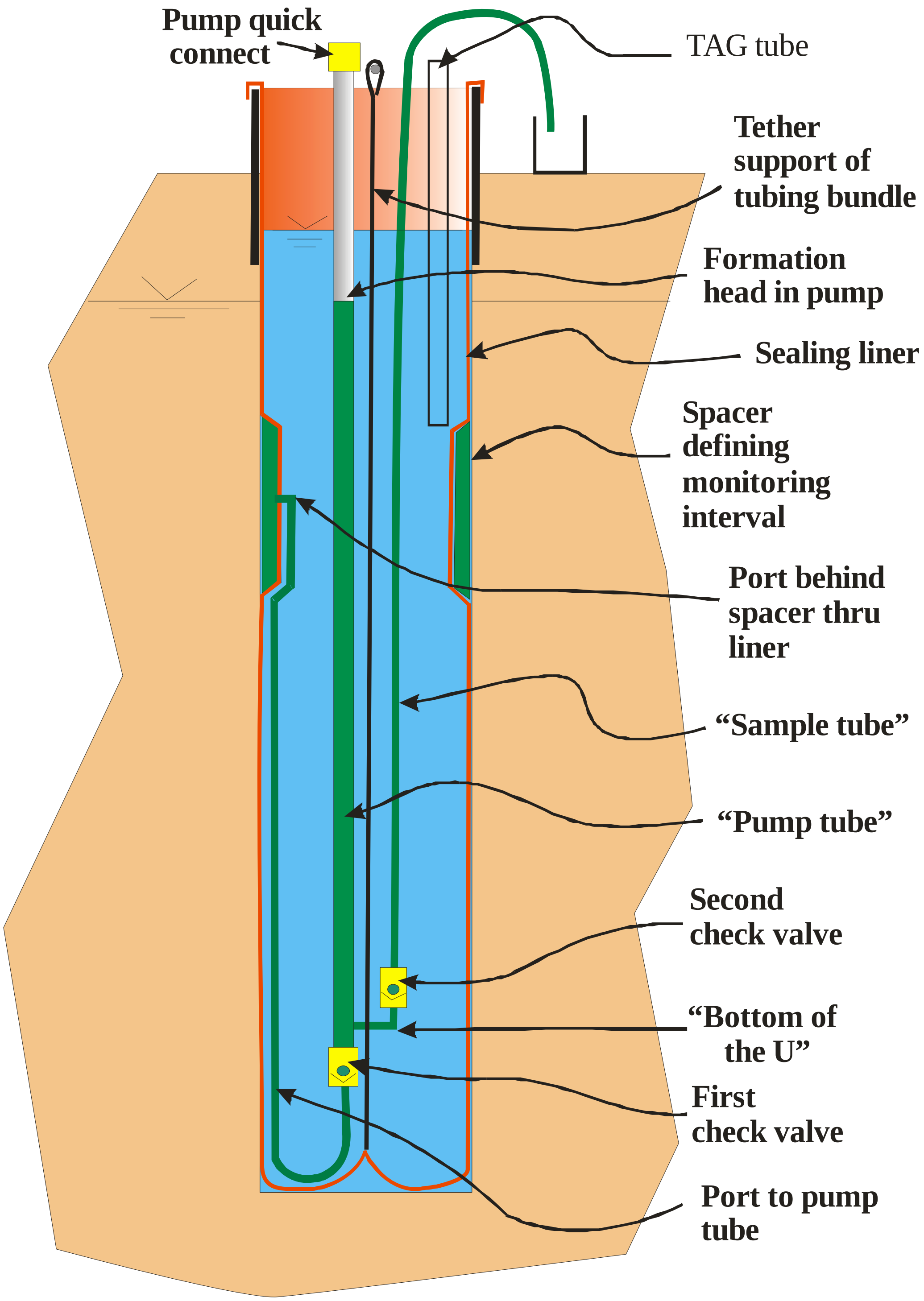
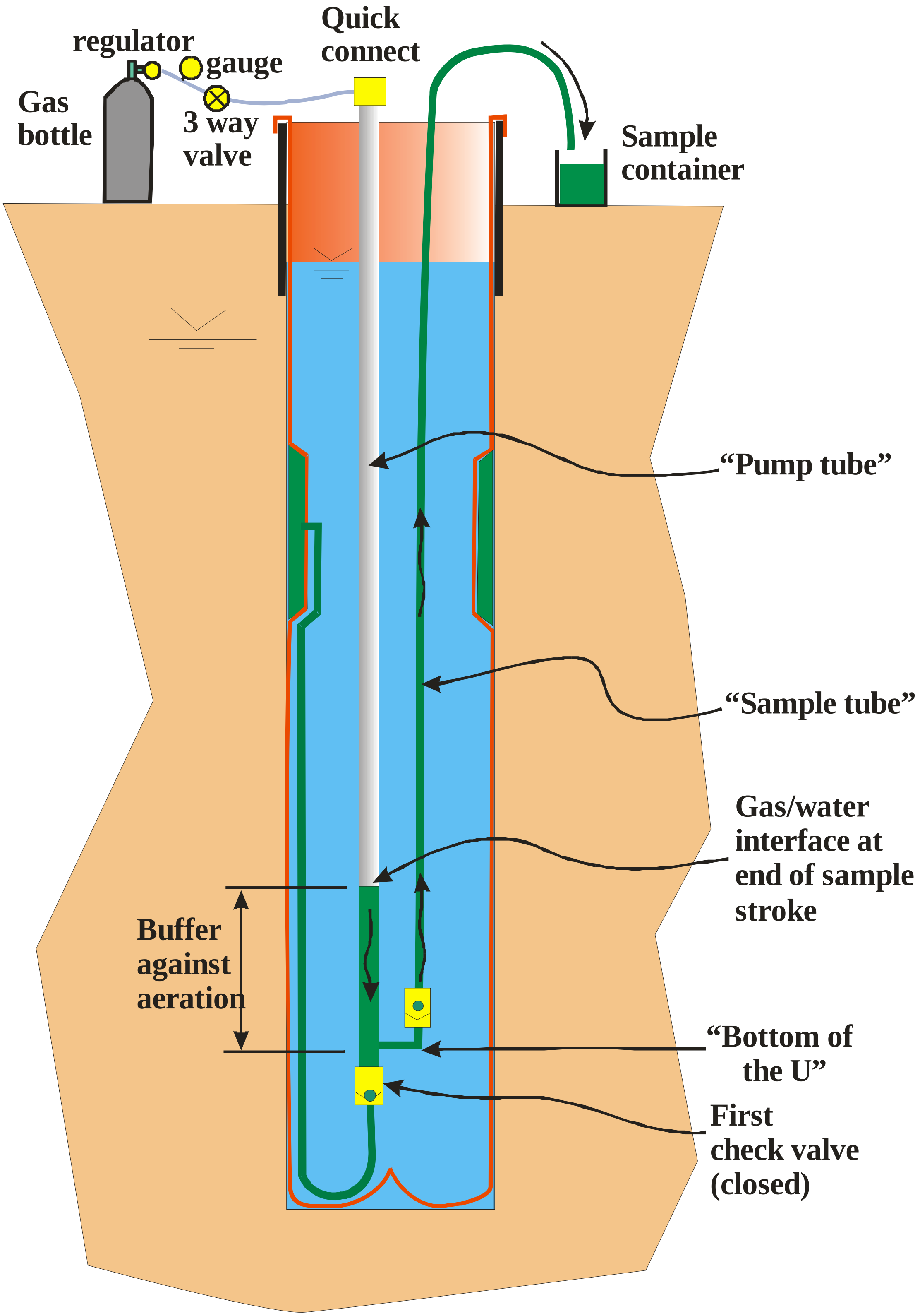


Fig. 2. Pumping Procedure



Quality Assurance Project Plan

For

Groundwater Sciences
In support of the Shenandoah Road
Groundwater Contamination Superfund Site
Alternative Water Supply

Prepared For:
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EnviroTest, Laboratory Director
Renee Cusack

Approved: ____________________ Date: ____________
Groundwater Sciences Corporation
Dorothy Bergmann, PG
Senior Hydrogeochemist

2.0 Table of Contents

3. DESCRIPTION

3.1 Introduction

This Quality Assurance Project Plan (QAPP) submitted by EnviroTest Laboratories describes the Quality Assurance and Quality Control (QA/QC) procedures employed to ensure the integrity, validity and usability of analytical results to be given in support of the Groundwater Sciences Corporation, Shenandoah Road Groundwater Contamination Superfund Site, Alternative Water Supply. These services will include sample analysis by EPA and NYSDEC approved methodologies. A project analyte list for this project is given in Table 1. Analytical methods are outlined in Section 9.0.

This QAPP presents, in specific terms, the policies, organization, objectives, functional guidelines and specific Quality Assurance and Quality Control activities designed to achieve the data quality requirements.

Table 1.0 Project Analyte List

Analyte, 8260C	**CAS #**	**"J" Value (2)**	**Reporting Limit(ug/L)**
1,1,1,2-Tetrachloroethane	630-20-6	0.11	1.0
1,1,1-Trichloroethane	71-55-6	0.16	1.0
1,1,2,2-Tetrachloroethane	79-34-5	0.16	1.0
1,1,2-Trichloroethane	79-00-5	0.09	1.0
1,1-Dichloroethane	75-34-3	0.12	1.0
1,1-Dichloroethene	75-35-4	0.18	1.0
1,1-Dichloropropene	563-58-6	0.14	1.0
1,2,3-Trichlorobenzene	87-61-6	0.25	1.0
1,2,3-Trichloropropane	96-18-4	0.16	1.0
1,2,4-Trichlorobenzene	120-82-1	0.19	1.0
1,2,4-Trimethylbenzene	95-63-6	0.12	1.0
1,2-Dibromo-3-Chloropropane	96-12-8	0.13	1.0
1,2-Dibromoethane	106-93-4	0.10	1.0
1,2-Dichlorobenzene	95-50-1	0.13	1.0
1,2-Dichloroethane	107-06-2	0.11	1.0

1,2-Dichloroethene, Total	540-59-0	0.13	1.0
1,2-Dichloropropane	78-87-5	0.19	1.0
1,3,5-Trimethylbenzene	108-67-8	0.11	1.0
1,3-Dichlorobenzene	541-73-1	0.13	1.0
1,3-Dichloropropane	142-28-9	0.14	1.0
1,4-Dichlorobenzene	106-46-7	0.12	1.0
1,4-Dioxane	123-91-1	5.83	50
2,2-Dichloropropane	594-20-7	0.26	1.0
2-Butanone	78-93-3	0.23	5.0
2-Chloroethyl vinyl ether	110-75-8	0.14	1.0
2-Chlorotoluene	95-49-8	0.12	1.0
2-Hexanone	591-78-6	0.55	5.0
4-Chlorotoluene	106-43-4	0.11	1.0
4-Isopropyltoluene	99-87-6	0.12	1.0
4-Methyl-2-pentanone	108-10-1	0.55	5.0
Acetone	67-64-1	0.31	5.0
Acrolein	107-02-8	0.49	1.0
Acrylonitrile	107-13-1	0.16	1.0
Allyl chloride	107-05-1	0.16	1.0
Benzene	71-43-2	0.12	1.0
Bromobenzene	108-86-1	0.10	1.0
Bromochloromethane	74-97-5	0.13	1.0
Bromodichloromethane	75-27-4	0.10	1.0
Bromoform	75-25-2	0.11	1.0
Bromomethane	74-83-9	0.14	1.0
Carbon disulfide	75-15-0	0.14	1.0
Carbon tetrachloride	56-23-5	0.20	1.0
Chlorobenzene	108-90-7	0.10	1.0
Chloroethane	75-00-3	0.17	1.0
Chloroform	67-66-3	0.16	1.0
Chloromethane	74-87-3	0.15	1.0
Chloroprene	126-99-8		1.0
cis-1,2-Dichloroethene	156-59-2	0.13	1.0
cis-1,3-Dichloropropene	10061-01-5	0.10	1.0
Dibromochloromethane	124-48-1	0.15	1.0
Dibromomethane	74-95-3	0.21	1.0
Dichlorodifluoromethane	75-71-8	0.13	1.0
Ethyl methacrylate	97-63-2	0.08	1.0
Ethylbenzene	100-41-4	0.16	1.0
Freon TF	76-13-1	0.22	1.0
Hexachlorobutadiene	87-68-3	0.37	1.0
Isobutyl alcohol	78-83-1		50
Isopropylbenzene	98-82-8	0.09	1.0
m&p-Xylene	179601-23-1	0.17	1.0
Methacrylonitrile	126-98-7		1.0

Methyl iodide	74-88-4	0.35	1.0
Methyl methacrylate	80-62-6	0.17	1.0
Methyl t-butyl ether	1634-04-4	0.13	1.0
Methylene Chloride	75-09-2	0.08	1.0
Naphthalene	91-20-3	0.15	5.0
n-Butylbenzene	104-51-8	0.10	1.0
n-Propylbenzene	103-65-1	0.10	1.0
o-Xylene	95-47-6	0.11	1.0
Propionitrile	107-12-0		4.0
sec-Butylbenzene	135-98-8	0.11	1.0
Styrene	100-42-5	0.13	1.0
tert-Butylbenzene	98-06-6	0.10	1.0
Tetrachloroethene	127-18-4	0.16	1.0
Tetrahydrofuran	109-99-9	1.57	5.0
Toluene	108-88-3	0.12	1.0
trans-1,2-Dichloroethene	156-60-5	0.11	1.0
trans-1,3-Dichloropropene	10061-02-6	0.05	1.0
trans-1,4-Dichloro-2-butene	110-57-6	0.59	5.0
Trichloroethene	79-01-6	0.16	1.0
Trichlorofluoromethane	75-69-4	0.21	1.0
Vinyl acetate	108-05-4	0.16	1.0
Vinyl chloride	75-01-4	0.14	1.0
Xylenes, Total	1330-20-7	0.17	1.0

Metals	**Method Number**	**"J" ug/L**	**Reportin Limit ug/L**
Aluminum	EPA 200.8	9.9	20
Antimony	EPA 200.8	0.07	0.4
Arsenic	EPA 200.8	0.07	1.4
Barium	EPA 200.8	0.03	2.0
Cadmium	EPA 200.8	0.04	1.0
Chromium	EPA 200.8	0.04	7.0
Cobalt	EPA 200.8	0.01	1.0
Copper	EPA 200.8	0.06	1.0
Iron	EPA 200.7	22	60
Lead	EPA 200.8	0.08	1.0
Nickel	EPA 200.8	0.17	0.5
Thallium	EPA 200.8	0.03	0.3
Zinc	EPA 200.8	0.26	10

Wet Chemistry	**Method Number**	**Reporting Limit Water mg/L**
Dissolved Oxygen	EPA 4500 OC	1.0
Nitrate as N	EPA 300	0.25

Total Dissolved Solids	SM 2540C	5.0

(1) “J” values for volatile organics are determined from the standard concentration used when IDL/MDL’s are determined. Values greater than 0.5ug/l are determined from the QEC vial certificate of analysis and satisfy the requirements of “EPA Publication #9240.0-05A” Specifications and Guidance for Contaminant-Free Containers. The “B” value for inorganics is the actual instrument detection limit.

4.0 Organization and Personnel

4.1 QA Policy and Objectives

It is EnviroTest’s policy to:

- provide high quality, consistent, and objective environmental testing services that meet all federal, state, and municipal regulatory requirements.
- generate data that are scientifically sound, legally defensible, meet project objectives, and are appropriate for their intended use.
- provide EnviroTest clients with the highest level of professionalism and the best service practices in the industry.
- build continuous improvement mechanisms into all laboratory, administrative, and managerial activities.
- maintain a working environment that fosters open communication with both clients and staff.

Management Commitment to Quality Assurance

EnviroTest Management is committed to providing the highest quality data and the best overall service in the environmental testing industry. To ensure that the data produced and reported by EnviroTest meet the requirements of its clients and comply with the letter and spirit of municipal, state and federal regulations, EnviroTest maintains a Quality System that is clear, effective, well communicated, and supported at all levels in the company.

EnviroTest Mission Statement

EnviroTest is a full-service, regional laboratory certified in New York, New Jersey, and Connecticut. We perform a full suite of on-site environmental analytical tests – from wet chemistry to metals to volatile organics in drinking water, waste water and soil.

Since 1974, EnviroTest has built a reputation based on our quality and depth of service. Our senior staff average 20 years of experience in the environmental testing field, and the significant breadth of both our organic and inorganic systems allows us to provide our customers with a wide range of services here in Newburgh.

We pride ourselves in our commitment to our clients. Our core values reflect our belief in client satisfaction through superior service, quality and performance.

- Dedication to excellence in three core areas:

  1. Service – how we serve our clients.
  2. Quality – how we collect and report our data
  3. Performance – how we perform as a business

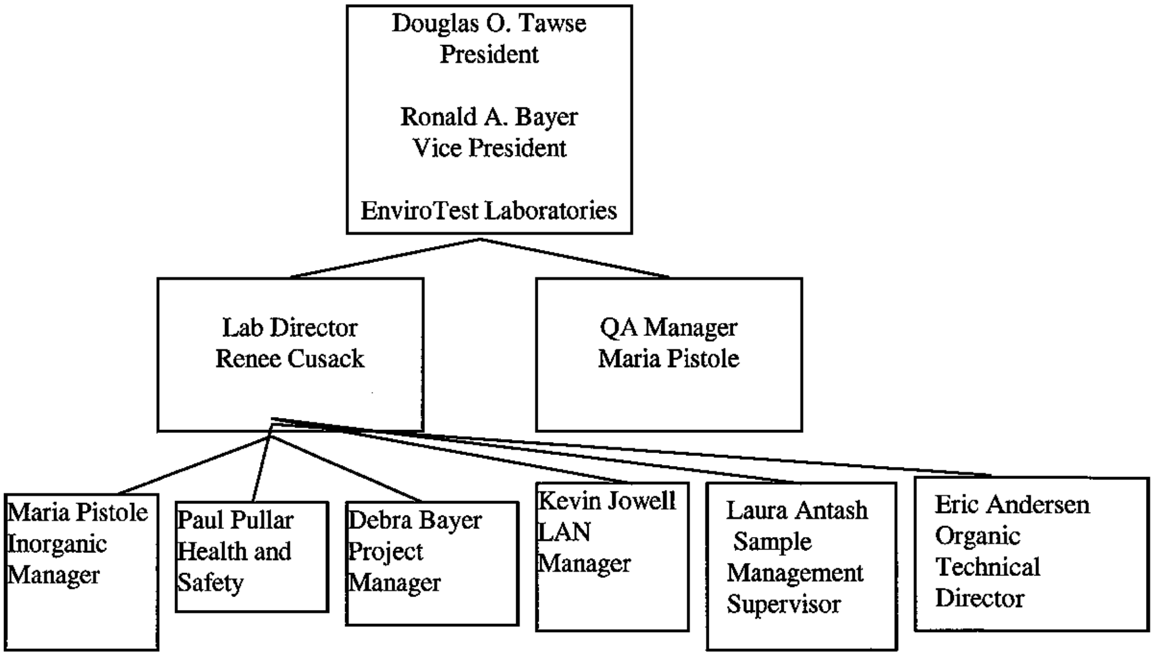
- Teamwork and personal accountability in delivering results that meet the needs of our clients.

- Helping to provide environmental solutions that matter to our clients, our company, and the natural world.

4.2 QA Management

4.2.1 Organization and Responsibilities

A functional organizational chart of the individuals associated with Quality Assurance Management follows. The responsibilities of the individuals associated with Quality Assurance Management are described below. A list of EnviroTest personnel including education and experience is found in Table 7.



The Project Manager has overall responsibility for management of the analytical requirements for sample analysis. The duties and responsibilities of the Project Manager are to:

- Administer and supervise all requirements of the analytical tasks to ensure meeting the client objectives on schedule.
- Act as liaison between the laboratory and the client to discuss and resolve any problems that may occur.
- Work with laboratory supervisors in planning and conducting progress meetings.
- Take part in corrective actions.

The Sample Management Supervisor acts as sample custodian for the laboratory. The duties and responsibilities of the Sample Management Supervisor are to:

- Sign for the incoming field samples and verify the data entered on the chain-of-custody forms.
- Advise the Project Manager of discrepancies, omissions or inappropriate samples as listed in the sample receiving SOP.
- Prepare laboratory internal chain-of-custody documents.
- Oversee sample information entry into the laboratory sample data base.
- Responsible for the distribution and storage of all samples accepted by EnviroTest.

- Transfer sample and laboratory internal chain-of-custody documents to Laboratory Supervisors.

The LAN Manager is responsible for:

- The management and quality control of all computing systems.
- The installation, operation and maintenance of software and programs

The QA Manager is responsible for reviewing and advising on programs all aspects of QA/QC. The duties and responsibilities of the QA Manager are to:

- Assist the Project Manager in specifying QA/QC procedures to be used during sample analysis.
- Implement quality control procedures and techniques to assure that the laboratory achieves established standards of quality.
- Evaluate data quality and maintain records on related QC charts and other pertinent information.
- Monitor laboratory activities to determine conformance with the authorized quality assurance policy, and to implement appropriate steps to ensure adherence to quality assurance programs.
- Coordinate internal audits with the Project Manager.
- Review performance evaluation results.
- Administer intralaboratory and interlaboratory QA efforts.
- Prepare quality assurance report to management

The Laboratory Supervisors and Technical Directors are responsible for meeting all the technical and analytical terms and conditions for sample analysis. Their areas of responsibilities are to:

- Organize the personnel, equipment and materials in a manner required to fulfill the analytical requirements of sample analysis.
- Oversee all aspects of laboratory analyses and provide technical support when necessary.
- Review analytical data for validity and clarity.
- Maintain contract with the Project Manager in areas of technical concern, and advise the Project Manager of analytical progress, needs of potential problems that occur.

The Sample Analysts are responsible for the analysis of samples. The analysts will:

- Schedule, prepare and analyze samples according to the method specific requirements indicated by the chain-of custody or CPO.
- Advise the laboratory supervisor of progress, needs and potential problems that occur.
- Verify that the laboratory QC and analytical procedures are being followed as specified.
- Review sample QC data, at least daily, including inspection of raw chromatograms and calibration curves.
- Inform laboratory supervisors if the daily review indicates a decline in data quality and implement actions.

The Health and Safety Officer is responsible for the overall safety of laboratory operations. The Health and Safety Officer will:

- Provide safety training to all new employees and on-going safety training to all employees.
- Maintain Material Safety Data Sheets and ensure that all employees have access to such documents.
- Have ultimate control over all emergency situations that may occur in the laboratory.

4.3 Project Document Control Procedures

The goal of the document control program is to assure that all documents for a group of samples will be accounted for. Before releasing analytical result, the laboratory assembles and cross checks the information of custody records, lab bench sheets, analyst and instrument logs and other relevant data to ensure that data pertaining to each particular sample is consistent throughout the record.

4.3.1 Sample File Organization, Preparation and Review Procedures

Project file folders will be created, when required, following completion of the project. One file folder will be assigned for each separate project. All documents, sample tags (if applicable), custody forms, and all other laboratory data pertaining to a particular case will be placed in the folder. Project file folders will be filed in numerical order and stored in a secure area with access limited to authorized personnel. Authorized personnel are limited to Supervisors, Lab Director, QC Officer, Sample Custodian or designee.

4.4 Request, Tender, and Contract Review

4.4.1 Contract Review

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 EnviroTest's intent to provide both standard and customized environmental laboratory services to our clients. To ensure project success, technical staff perform a thorough review of technical and QC requirements contained in contracts. Contracts are reviewed for adequately defined requirements and EnviroTest's capability to meet those requirements.

All contracts entered into by EnviroTest are reviewed and approved by the appropriate personnel at the facility or facilities performing the work. Any contract requirement or amendment to a contract communicated to EnviroTest verbally is documented and confirmed with the client in writing. Any discrepancy between the client's requirements and EnviroTest's capability to meet those requirements is resolved in writing before acceptance of the contract. Contract amendments, initiated by the client and/or EnviroTest, are documented in writing for the benefit of both the client and EnviroTest.

All contracts, Quality Assurance Project Plans (QAPPs), Sampling and Analysis Plans (SAPs), contract amendments, and documented communications become part of the permanent project record.

4.4.2 Project Specific Quality Planning

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, EnviroTest assigns a Project Manager (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 communicated to the laboratory personnel before and during the project. The Project Manager for the Shenandoah Road Groundwater Contamination Superfund Alternative Water Supply is Debra Bayer.

Each EnviroTest facility has established procedures in order to ensure that communication is inclusive and effective. These include project memos, designation and meetings of project teams, and meetings between the laboratory staff and the client. EnviroTest has found it very effective to invite the client into this process. EnviroTest strongly encourages our clients to visit the laboratories and hold formal or informal sessions with employees in order to effectively communicate client needs on an ongoing basis, as well as project specific details for customized testing programs.

4.4.3 Subcontracting

Subcontracting is arranged with the documented consent of the client, in a timely response that shall not be unreasonably refused. 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. Proof of required certifications from the subcontract facility are maintained in EnviroTest project records. Where applicable, specific QC guidelines, QAPPs, and/or SAPs are transmitted to the subcontract laboratory. Samples are subcontracted under formal Chain of Custody (COC). A separate QAPP for the subcontract work will be prepared by the subcontract laboratory and submitted under separate cover.

Subcontract laboratories may receive an on-site audit by a representative of EnviroTest's QA staff if it is deemed appropriate by the QA Manager. The audit involves a measure of compliance with the required test method, QC requirements, as well as any special client requirements.

Project reports from external subcontract laboratories are not altered and are included in original form in the final project report provided by EnviroTest.

4.4.4 Purchasing Services and Supplies

Evaluation and selection of suppliers and vendors is done, in part, on the basis of the quality of their products, their ability to meet the demand for their products 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, all purchases from specific vendors are approved by a member of the supervisory or management staff.

Chemical reagents, solvents, glassware, and general supplies are ordered as needed to maintain sufficient quantities on hand. Purchasing guidelines for equipment and reagents meet with the requirements of the specific method and testing procedures for which they are being purchased.

All sample containers will meet the QA/QC specifications in EPA Publication 9240.0-05A "Specifications and Guidance for Contaminant Free Sample Containers".

4.4.5 Instrument Maintenance Activities and Schedules

A complete listing of instrumentation may be found in Table 9. Instrument preventative maintenance and careful calibration help to assure accurate measurements from laboratory instruments. All laboratory instrumentation is on a service contract with the applicable instrument manufacturer or licensed service organization. The service contracts include regular preventative maintenance service calls on a scheduled basis.

Preventative maintenance procedures such as lubrication, source cleaning, detector cleaning and the frequency of such maintenance are performed according to the procedures delineated in the manufacturer's instrument manual or when deemed necessary by the analyst.

Instrument logbooks are in the laboratory at all times. They contain records of usage, calibration, maintenance and repairs. Adequate supplies of spare parts such as GC columns, syringes, septa, injection port liners, and electronic parts are maintained in the laboratory so that they are available when needed.

4.5 QA Document Control Procedure

4.5.1 Document Type

The following documents, at a minimum, are controlled at each EnviroTest Facility:

- Laboratory Quality Manual
- Standard Operating Procedures (SOP)
- Quality Management Plan

4.5.2 Document Control Procedure

Security and control of documents is necessary to ensure that confidential information is not distributed and that all current copies of a given document are from the latest applicable revision. Unambiguous identification of a controlled document is maintained by identification of the following items in the document header: Document Name, Document Number, Revision Number, Effective Date, Number of Pages. Controlled documents are authorized by Management and/or the QA Department. Controlled documents are marked as such and records of their distribution are kept by the QA Department.

Controlled documents are available at all locations where the operational activity described in the document is performed.

4.5.3 Document Revision

Changes to documents occur when a procedural change warrants a revision of the document. When an approved revision of a controlled document is ready for distribution, obsolete copies of the document are replaced with the current version of the document. The previous revision of the controlled document is archived by the QA Department.

4.6 Records

4.6.1 Record Types

Record types are described in Table 2.

Table 2 EnviroTest Record Types

[illegible]	Controlled Documents	[illegible]	[illegible] Records	[illegible]
Calibration	LQM	Audits/ Responses	COC Documentation	Accounting
Computer Tapes/Disks	QMP	Certifications	Contracts and Amendments	EH&S, Manual, Permits, Disposal Records
QC Samples	SOPs	Corrective Action	Correspondence	Employee Handbook
Sample data		Logbooks*	QAPP	OSHA 29 CFR Part 1910
Software (Version control)		Method & Software Validation, Verification	SAP	Personnel files, Employee Signature & Initials, Training Records
		Standards Certificates	Telephone Logbooks	Technical and Administrative Policies

*Logbooks: Maintenance, Instrument Run, Preparation (standard and samples), Standard and Reagent Receipt, Archiving, Balance Calibration, Temperature,

4.6.2 Record Retention

Table 3 outlines EnviroTest's standard record retention time. For raw data and project records, record retention is calculated from the date the project report is issued. For other records, such as Controlled Documents, QC, or Administrative Records, the retention time is calculated from the date the document is formally retired. Records related to the programs listed in Table 4 have lengthier retention requirements and are not subject to EnviroTest's standard record retention time.

Table 3 EnviroTest Record Retention

[illegible]	[illegible]	[illegible]
Raw Data	All*	5 Years from project completion
Controlled Documents	All*	5 Years from document retirement date
QC	All*	5 Years from archival
Project	All*	5 Years from project completion
Administrative	Personnel/Training	7 years
	Accounting	See Accounting and Control Procedures Manual

* Exceptions listed in Table 5.

4.6.3 Programs with Longer Retention Requirements

Specific client projects and regulatory programs have longer record retention requirements than the EnviroTest standard record retention length. In these cases, the longer retention requirement is noted in the archive. 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.

Programs with record retention requirements greater than five years are detailed in Table 4.

Table 4 Special Record Retention Requirements

[illegible]	Retention Requirement
Commonwealth of MA – All environmental data 310 CMR 42.14	10 years
NY Potable Water NYCRR Part 55-2	10 years
OSHA - 40 CFR Part 1910	30 years
Pennsylvania – Drinking Water	10 years
TSCA - 40 CFR Part 792	10 years after publication of final test rule or negotiated test agreement

4.6.4 Archives and Record Transfer

Archives are indexed such that records are accessible on either a project or temporal basis. Archives are protected against fire, theft, loss, deterioration, and vermin. Electronic records are protected from deterioration caused by magnetic fields and/or electronic deterioration. Access to archives is controlled and documented.

EnviroTest ensures that all records are maintained as required by the regulatory guidelines and per the QMP upon facility location change or ownership transfer.

All observations and results recorded by EnviroTest are entered into the laboratory data entry system or into permanent laboratory logbooks. Data recorded are referenced with the sample laboratory number, date and analyst's signature at the top of the page.

All logbooks and other document entries are made in ink. Any corrections made in a logbook will be made by crossing a line through the error and entering the correct information. The person will subsequently date and initial the correction. Corrections made to other data records are made by crossing a single line through the error, entering the correct information and initialing and dating the correction.

All chemicals and reagents received by EnviroTest must be dated upon receipt, and again dated and initialed upon opening.

The preparation of all standards and reagents must be in accordance with the written SOP. Preparation must be documented in a bound preparation log. Documentation must include the date, analyst initials, identification of stock source and the final concentration of the solution.

Once in the possession of the Analyst, all logbooks are their responsibility to maintain. No logbooks are permitted outside the laboratory. Analysts are responsible for proper documentation in the logbooks. Once a Logbook has been completed it is returned to QA Manager for proper archiving.

4.7 Service to the Client

4.7.1 Sample Acceptance Policy

Samples are considered "compromised" if the following conditions are observed upon sample receipt:

- Cooler and/or samples are received outside of temperature specification.
- Samples are received broken or leaking.
- Samples are received beyond holding time.
- Samples are received without appropriate preservative.
- Samples are received in inappropriate containers.
- COC does not match samples received.
- COC is not properly completed or not received.
- Breakage of any Custody Seal.
- Apparent tampering with cooler and/or samples.
- Headspace in volatiles samples.
- Seepage of extraneous water or materials into samples.
- Inadequate sample volume.
- Illegible, impermanent, or non-unique sample labeling.

When "compromised" samples are received, it is documented in the project records and the client is contacted for instructions. If the client decides to proceed with analysis, the project report will clearly indicate any of the above conditions and the resolution.

4.7.2 Client Confidentiality and Proprietary Rights

Data and sample materials provided by the client or at the client's request, and the results obtained by EnviroTest, shall be held in confidence (unless such information is generally available to the public or is in the public domain or client has failed to pay EnviroTest for all services rendered or is otherwise in breach of the terms and conditions set forth in the EnviroTest and client contract) subject to any disclosure required by law or legal process. EnviroTest's reports, and the data and information provided therein, are for the exclusive use and benefit of client, and are not released to a third party without written consent from the client.

4.7.3 Samples Tracking/Custody Procedures

- Sample are received at the laboratory by the sample custodian or designee who removes the samples from the shipping containers together with all accompanying documentation such as chain-of-custody forms, analysis request forms, etc.
- The condition of the custody seal is examined and recorded in a bound notebook.
- The temperature of the shipping container upon receipt will be recorded on the chain of custody.
- The pH of the sample (when required) will be taken upon receipt. Any inappropriate pH reading will be recorded on the chain of custody. Necessary pH adjustments will be made as required and documented.
- The samples are inspected for general condition and the letter of chain of custody received with any samples is examined for discrepancies between package contents and the enclosed documents.
- Discrepancies, omissions, or inappropriate samples discovered will be noted and discussed with the Project Manager who will contact the client to resolve the problem.
- If the client cannot be reached, the samples will be assigned to cold storage (4 degrees +- 2 degrees C) until the problem is resolved.
- Samples delivered directly by the sample collector are received and inspected by the Sample Custodian or designee in the presence of the sample collector. Discrepancies, omissions, or inappropriate samples should be noted and discussed with the sample collector to resolve the problem.
- Samples receipted through chain of custody by the Sample Custodian of designee will be assigned an EnviroTest laboratory number.
- The Sample Custodian or designee will complete the EnviroTest Sample Log with the EnviroTest laboratory number and corresponding client number. The EnviroTest laboratory number will be written on the client sample bottle or adhered via printed label to the client sample bottle.
- All documents will be reviewed a second time to ensure that there are no transposition errors. The project manager or designee will validate the accuracy of the sample log-in procedure by initialing the appropriate space on the COC.
- The samples will be entered by sample entry into the laboratory sample data-base upon successful completion of the sample log-in procedure. Sample entry will prepare a laboratory chronicle for all projects that will be used for

regulatory purposes. All documents, sample tags, shipping labels, etc. will be stapled to the original COC.

- Once in the possession of the Laboratory, all samples and extracts are stored and refrigerated in areas that are accessible only to Laboratory personnel. The sample custodian will oversee all movement of samples in and out of refrigerators. All refrigerators are locked during non-routine working hours.
- Access to the Laboratory facilities is limited to Laboratory personnel, with certain areas accessible only to Laboratory Management.
- All Samples are stored at the Laboratory for a minimum of 30 days after receipt and are not disposed of until at least one week after the final report has been issued.
- Samples are preserved per requirements or specific regulatory programs.

4.8 Complaints

Client complaints are documented, communicated to management, and addressed promptly and thoroughly. Client complaints are documented by the employee receiving the complaint. The documentation can take the form of a corrective action report (as described in Section 4.10) or in a format specifically designed for that purpose. The Laboratory Director, Project Manager, and QA Manager are informed of all client complaints, and assist in resolving the complaint.

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 is required to conduct a special audit to assist in resolving the issue. A written confirmation, or letter to the client, outlining the issue and response taken is usually part of the overall action taken.

The number and nature of client complaints is reported to the Corporate QA Manager in the QA Monthly report submitted by each facility. The overall number of complaints received per facility is tracked and the appropriateness of the response to client complaints is assessed. Monitoring and addressing the overall level and nature of client complaints and the effectiveness of the solutions is part of the Management Systems Review.

4.9 Control of Non-conformances

Non-conformances include any out of control occurrence. Non-conformances may relate to client specific requirements, procedural requirements, or equipment issues. All non-conformances in the laboratory are documented at the time of their occurrence.

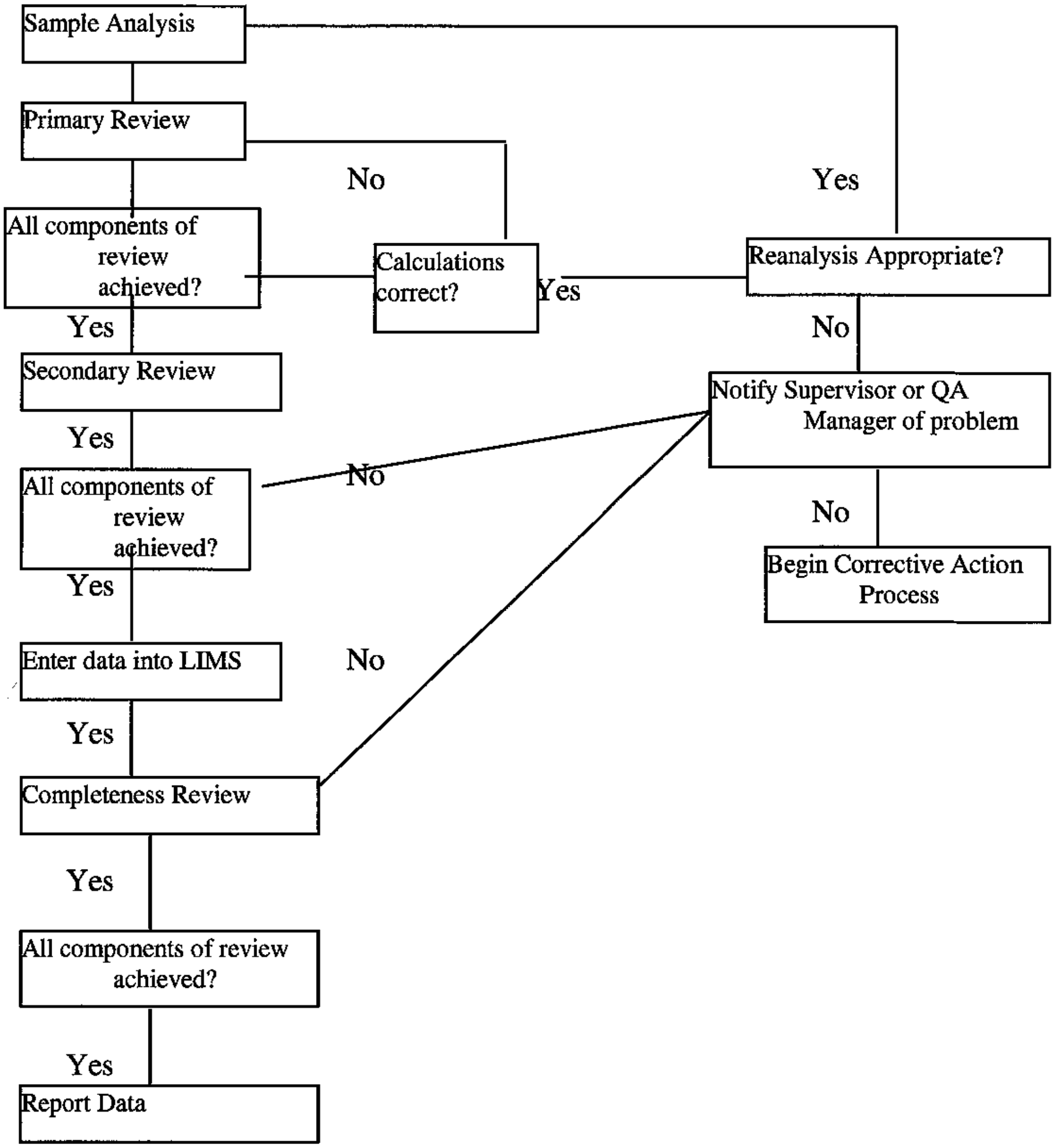
All non-conformances that affect a sample and/or sample data become part of the affected project's permanent record. When appropriate, reanalysis is performed where QC data falls outside of specifications, or where data appears anomalous. If the reanalysis comes back within established tolerances, the results are approved. If the reanalysis is still outside tolerances, further reanalysis or consultation with the Supervisor, Manager, Project Manager, Laboratory Director, or QA Manager for direction may be required. All records of reanalysis are kept with the project files.

Where non-conformances specifically affect a client's sample and/or data, the client is informed and action must be taken. Action can take the form of reporting and flagging the data, and including the non-conformance in the project narrative or cover letter.

4.10 Corrective Action

An important part of any quality assurance program is a well-defined, effective policy for correcting quality problems. This is depicted in the figure 1. EnviroTest maintains a closed-loop corrective action system, which operates under the directions of the QA Manager. While the entire quality assurance program is designed to avoid problems, it also serves to identify and correct those that may exist. Usually these quality problems fall into two categories, immediate corrective action or long- term corrective action.

Figure 1: EnviroTest Decision Processes, Procedures and Responsibility for Initiation of Corrective Action



Specific quality control procedures are designed to help analysts detect the need for corrective action. Often an analyst's experience will be most valuable in identifying suspicious data or malfunctioning equipment; and an immediate corrective action may then be taken. The actions should be noted in laboratory notebooks but no other formal documentation is required unless further corrective action is necessary.

The need for long-term action may be identified by standard QC procedures, control charts, performance or system audits. Any quality problem which can not be solved by immediate corrective action falls into this long-term category. EnviroTest uses a system to insure that the condition is reported to a person who is part of the closed-loop action and follow up plan (figure 1)

The essential steps in the closed –loop corrective action system are:

- the problem will be identified
- responsibility for investigating the problem will be assigned.
- The cause of the problem will be investigated and determined.
- A corrective action to eliminate the problem will be determined
- Responsibility for implementing the corrective action will be assigned and accepted.
- The effectiveness of the corrective action will be established and corrective action implemented
- The fact that the corrective action has eliminated the problem will be verified
- The complete process of establishing and implementing corrective action will be documented.

This process of corrective action will be used to make all corrections deemed necessary by the EnviroTest Project Manager or QA/QC Department.

4.11 Preventative Action

Preventative action is defined as noting and correcting a problem before it happens, because of a weakness in a system, method, or procedure. Preventative action includes analysis of the Quality System to detect, analyze, and eliminate potential causes of non-conformances. When potential problems are identified, preventative action is initiated to effectively address the problem to eliminate or reduce the risk identified. The preventative action process takes the same format as the corrective action process

5.0 Data Generation and Validation

5.1 Data Reduction

Analysis results will be reduced to the concentrations units specified in the analytical procedures using the equations provided in the analytical references listed in section 9. All calculations will be independently checked by senior laboratory staff.

5.2 Data Validation

Data validation is the process by which analytical data are evaluated and accepted or rejected based on a set of criteria. EnviroTest personnel use the following criteria in the validation of laboratory data:

- use of published or approved analytical procedures
- use of properly operating and calibrated instrumentation
- precision and accuracy achieved comparable to that achieved in similar analytical programs
- precision, accuracy and blank contamination meeting the analysis specified criteria as and/or the criteria found in the applicable method.
- completeness of data set.

All data will be validated by laboratory supervisors and QA/QC Director prior to being released for reporting purposes to the EnviroTest Project Manager. The persons validating the data will have sufficient knowledge of the technical work to identify questionable values. All analyses requiring EnviroTest protocols will be validated in accordance with the requirements of those protocols.

5.3 Data Reporting and Authorization Procedures

Key personnel who will handle data gathering and evaluation are shown in the EnviroTest Organizational Chart. EnviroTest uses a computerized sample tracking for routine tracking and reporting of analysis data.

5.4 Data Review

5.4.1 Primary Review

The primary review is often referred to as a “bench-level” review. In most cases, the analyst who generates the data (i.e. logs in, prepares and/or runs the samples) is the primary reviewer. In some cases, an analyst may be reducing data for samples run by an auto-sampler set up by a different analyst. In this case, the identity of both the analyst and the primary reviewer is identified in the raw data.

One of the most important aspects of primary review is to make sure that the test instructions are clear, and that all project specific requirements have been understood and followed. If directions to the analyst are not clear, the analyst must go to the Supervisor, QA Manager, or Project Manager, who must clarify the instructions.

Once an analysis is complete, the primary reviewer ensures that:

- Sample preparation information is complete, accurate, and documented.
- Calculations have been performed correctly.
- Quantitation has been performed accurately.
- Qualitative identifications are accurate.
- Client specific requirements have been followed.
- Method and process SOPs have been followed.
- Method QC criteria have been met.
- QC samples are within established limits.
- Dilution factors are correctly recorded and applied.
- Non-conformances and/or anomalous data have been properly documented and appropriately communicated.
- COC procedures have been followed.

Any anomalous results and/or non-conformances noted during the Primary Review are communicated to the Supervisor and the Project Manager for resolution. Resolution can require sample reanalysis, or it may require that data be reported with a qualification.

5.4.2 Secondary Review

The secondary review is a complete technical review of a data set and is completed by the section supervisor. The secondary review is documented and the secondary reviewer is identified. The following items are reviewed:

- Qualitative Identification
- Quantitative Accuracy
- Calibration
- QC Samples
- Method QC Criteria
- Adherence to method and process SOPs

If problems are found during the secondary review, the reviewer must work with the appropriate personnel to resolve them.

5.4.3 Completeness Review

The completeness review includes the generation of a project narrative and/or cover letter which outlines anomalous data and non-compliances using project narrative notes. The completeness review addresses the following items:

- Accuracy of Final Client Reporting Forms
- Manual Integrations – 100% as verified by signature of secondary data reviewer
- Completeness
- Special Requirements/Instructions
- Is the project report complete?
- Correct assembly of the final report.
- Does the data meet with the client's expectations?
- Were the data quality objectives of the project met?
- Have QC outages and/or non-conformances been approved and appropriately explained in the narrative notes?

If problems are found during the secondary review, the reviewer must work with the appropriate personnel to resolve them. If changes are made to the data, such as alternate qualitative identifications, identifications of additional target analytes, re-quantitation, or re-integration, the secondary reviewer must contact the laboratory analyst and/or primary reviewer of the data so that the primary analyst and/or reviewer is aware of the appropriate reporting procedures.

6.0 QA Program

6.1 Levels of QC Efforts

Every attempt will be made to have all data generated be valid data. The precision of laboratory analysis will be evaluated using sample duplicates and matrix spike duplicates. Analytical accuracy will be monitoring using recovery of analytes from system monitoring compounds, matrix spikes, blank spikes, EPA reference check standards and Performance Evaluation (PE) samples. These quality control measures and frequencies are summarized in Section 8.1. These QA efforts will assist in determining the reliability of the analytical data.

6.2 Accuracy and Precision

Accuracy is a measure of the degree of agreement between the analyzed value and the true or accepted reference value where it is known. Accuracy is usually expressed as a percent recovery. Precision is a measure of the mutual agreement among individual measurements of the sample parameter under similar conditions, usually expressed as a relative percent difference or as standard deviation. Accuracy and precision in the laboratory are assessed by the regular analysis of known standards and duplicate samples.

6.3 Completeness

Completeness is a measure of the amount of valid data obtained from the analytical measurement system, expressed as a percentage of the number of valid measurements that should have been or were planned to be collected. EnviroTest will make every attempt to generate valid data from all samples received. However, realistically, some samples may be lost in laboratory accidents or some results may be deemed questionable based on internal QC procedures. Due to the variable nature of the completeness value, the objective will be to have data completeness for all samples received for analysis as high as possible to meet completeness objectives as described by the client.

6.4 Representativeness

Representativeness is a measure of how closely the measured results reflect the actual concentration of distribution of the chemical compounds in the sample. Sampling will be performed by the client. Sample handling protocols (e.g., storage, preservation and transportation) have been developed to preserve the representativeness of the collected samples. Proper documentation will establish that protocols have been followed and that sample identification and integrity have been assured.

6.5 Comparability

Comparability is a QA objective wherein all sample data is comparable with other representative measurements made by EnviroTest or another organization. EnviroTest will achieve comparability by operating within the instrument linear range and by strict adherence to analytical protocols. The use of published analytical methods, standards reporting units and thorough documentation will ensure meeting this objective.

7.0 Quality Control

7.1 Internal Quality Control

Quality control is the routine application of procedures for obtaining prescribed standards of performance in the monitoring and measurement process. Quality Control checks are the application of EnviroTest program for laboratory analysis in order to ensure the generation of valid analytical results on project samples. These checks are performed by project participants throughout the program, under the guidance of the Quality Assurance Manager.

7.2 Quality Control Samples

EnviroTest makes use of a number of different types of QC samples to document the validity of the generated data. These are summarized in Table 6. The following types of QC samples are used routinely:

A. <u>Blank Samples</u> - Blanks are used to assess contamination introduced in transit, storage or in the laboratory.

- Preparation Blanks – For inorganic analyses, these deionized water blanks are prepared using the same reagents and analytical procedures as the samples, in order to assess possible laboratory contamination.
- Laboratory Method Blanks – For organic analyses, theses blanks are "clean" samples, prepared in the laboratory to include surrogates, and analyzed according to a prescribed method in order to assess possible laboratory contamination.
- Laboratory Holding Blank – For organic analyses, these blanks are placed in cold storage with the volatile organic samples during the holding time to assess contamination which may be introduced in storage.
- Storage Blank – For organic analyses, these blanks are placed in the sample container storage area to assess contamination that may be introduced in storage.
- Calibration Blanks – For all analyses, these blanks are used in instrument calibration and contain all the reagents used in preparing instrument calibration standards except the parameters of interest.

B. <u>Initial and Continuing Calibration Verification</u> - Verification samples are analyzed during each analysis run to assure calibration accuracy for each analyte. For inorganic analysis, theses are prepared from a source other than that used for calibration.

C. <u>System Monitoring compound</u> – For organic analyses, all samples are spiked with surrogate compounds prior to sample preparation in order to assess the behavior of actual components in individual samples during the entire preparative and analysis scheme. Surrogate standard compounds are chemically similar to compounds of interest (target compounds).

D. Matrix Spikes/Analytical Spikes – For all analyses at frequencies particular to each method, spiking solutions are added to samples in order to evaluate any matrix effects of the sample on the analytical method. Matrix spikes and analytical spikes are performed using actual elements of interest or target compounds.

E. Duplicate Samples – For all analyses, a second aliquot of a sample carried through all sample preparation procedures to verify the precision of the analytical method. At least one sample in each analysis batch of 20 or fewer samples is analyzed in duplicate.

F. Laboratory Control Samples – For inorganic analyses, at least one sample in each preparation batch of 20 or fewer samples is prepared and analyzed for each analyte of interest, in order to verify the preparation and analytical methods.

G. Blank Spikes - For organic analyses, reagent water is spiked with all the target analytes.

Reagents used in the laboratory are normally of analytical reagent grade or higher purity. Each lot of acid or solvent received is checked for acceptability prior to lab use. All reagents are labeled with the date received and date opened. The quality of the laboratory deionized water is continuously monitored through the use of an in-line conductivity meter. The deionized water used at EnviroTest is run through activated carbon, a cation resin, an anion resin, a mixed bed resin followed by a final mixed bed resin and is used only for inorganic analyses. The organic free water is carbon filtered and is used only for organic analyses. The deionized water and organic free water is verified daily by the analysis of the prep blank water for inorganics and by the analysis of the method blank for volatile organics. At the time of field blank preparation., a sample is taken of the deionized water and organic free water and is either analyzed immediately or held by the laboratory to be analyzed if contamination of the field blank is determined.

7.3 Internal Quality Assurance

To monitor quality, EnviroTest QA/QC Department conducts internal quality assurance audits including:

A. Internal Data Audit - Once per month a representative set of data is chosen randomly from work completed the previous month for one or more of EnviroTest's Commercial clients. This data review includes each laboratory section.

B. Internal Laboratory Audits - The QA/QC Directory will perform laboratory audits quarterly or as needed. This involves evaluation of:

- sample storage
- chain of custody
- instrument maintenance
- documentation
- precision
- accuracy

C. Sample Bottle Verification – A representative bottle is chosen randomly from each new batch and container type. The container is analyzed for all analytes collected in that specific container. All results must be approved by the QA/QC manager before bottles from lot are released.

In addition the QA/QC manager will meet frequently with the project manager and laboratory supervisor to review QA/QC data summaries and other pertinent information.

7.4 System and Performance Audits

7.4.1 System Audits

A system audit is an evaluation of the various components of a laboratory's measurements system to assess proper selection and use. This audit will consist of an on-site review of a laboratory's quality assurance system and physical facilities for sampling, calibration and measurements. System audits are performed on a regular basis by the various regulatory agencies. The audit may included several or all of the components listed below:

- Personnel, facilities and equipment
- Chain - of - custody procedures
- Instrument calibration and maintenance
- Standards preparation and verification
- Analytical procedures
- Quality control procedures
- Data handling procedures
- Documentation control procedures

7.4.2 Performance Audits

Performance audits provide a systematic check of laboratory operations and measurement systems by comparing independently obtained data with routinely obtained data. To fulfill the PT requirements for NELAC accreditation, EnviroTest routinely participates in laboratory performance evaluations received from the NYSDOH ELAP as part of the Potable and Non-Potable Water/Solid & Hazardous Waste/Air & Emissions Chemistry Proficiency Programs. EnviroTest also analyzes proficiency samples to maintain participation in the NYSDEC CLP program. A schedule for EnviroTest participation in these performance evaluations is detailed in Table 5.

Table 5 Laboratory Performance Evaluation Schedule (1 year)

Source	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
NYSDOH Potable		X		X
NYSDOH Non-Potable Solid & Hazardous Waste Chemistry	X		X	

7.5 Detection Limits

7.5.1 Instrument Detection Limit

The Instrument Detection Limit (IDL) is the level at which the instrument can reliably detect an analyte response. Method-specific Sample preparation steps are not considered in the IDL calculation. IDL's will be determined on a quarterly basis according to the following schedule:

- The first week of January
- The first week of April
- The first week of July
- The first week of October

Inorganic IDL Determination

Inorganic IDL's are determined by multiplying by the t-Test the standard deviation obtained for the analysis of a standard solution (each analyte in reagent water) at a concentration of 3x-5x estimated IDL on three non-consecutive days with seven consecutive measurements per day.

Organic IDL Determination

Organic IDL's are determined by multiplying by the t-Test the standard deviation obtained for three to seven replicate analyses of a standard solution (each analyte in reagent water).

The IDL is calculated by multiplying the standard deviation by the students t-Test (tn-1) value.

No. of Samples	t-statistic
3	6.96
4	4.54
5	3.75
6	3.36
7	3.14

7.5.2 Method Detection Limit

The Method Detection Limit (MDL) is the minimum concentration of an analyte that can be measured and reported with 99% confidence that the analyte concentration is greater than zero. A MDL utilizes all preparatory steps in the final detection.

To obtain an MDL:

- Seven method blank samples are spiked at a concentration that is two to five times the IDL, or estimated MDL
- The MDL is calculated by multiplying the t-Test value by the standard deviation obtained for three replicate analyses of a standard solution (each analyte in reagent water).

When a method requires that a method blank value is subtracted from the analyte response, the MDL calculations are made by subtraction the average of the individual method blank from each analyte response.

MDL's are determined annually, and when a new or changed instrument is utilized or when an analyst assumes a new method. The QA/QC

Department maintains copies of MDL Forms for all tests performed at EnviroTest.

7.6 Initial Demonstration of Capability

Prior to an analyst assuming responsibility for an analysis, an Initial Demonstration of Capability (IDC) must be performed and approved by the QA Supervisor.

- Unless specified otherwise in the method, the IDC shall consist of analyzing a standard solution at a concentration of between 2-5x's the MDL and having a percent recovery of ± 10% of the true value.
- For drinking water analysis the concentration of the standard solution shall be no more than 2-5x's the Maximum Contaminated Level (MCL).
- The QA/QC Department will maintain a file of all IDC's.
- In addition to the IDC, the analyst is also expected to be familiar with the analytical method and Laboratory SOP.
- The Section Supervisor is responsible for the proper training of all analysts and technicians.

8.0 Analytical Methodology

Calibration Procedures and Frequency

Instrument or method calibration is performed in accordance with the specific analytical methods and as outlined below. Quality control measures and frequency are performed as per the analytical methodology and, where applicable, evaluated using laboratory established control limits.

8.1 Volatile Organics - GC/MS

A. GC/MS instruments are tuned to meet required mass spectral abundance criteria prior to both initial and continuing calibrations. This is accomplished via the analysis of p-bromofluorobenzene (BFB).

B. Initial calibration of GC/MS volatiles consists of a 5 calibration standards containing each target analyte plus surrogate and internal standard compounds. The validity of the initial calibration is verified by:

- % relative standard deviation (RSD) of the relative response factor (RRF) for target compound.
- Minimum RRFs for each compound.
- Assessment of the relative retention time (RRT) shift for each compound between each standard run.

C. Continuing calibration is performed by analysis of a standard at a frequency of once every 12 hours. The continuing calibration standard must be preceded by a successful instrument tune. The validity of the continuing calibration is verified by:

- Assessment of % difference (%D) of the RRFs versus the initial calibration average RRF for each compound.
- Minimum RRFs for each compound.
- RRT shift for each compound between successive calibration runs.

D. Standards Preparation Procedures

Calibration Standards

- Purchase commercially available certified stock solutions.
- Prepare working standards by dilution of the stock standards.
- Verify the working standards by analysis of a calibration check standard prepared independently from standards.

8.2 Metals - ICP

A. Initial calibration for ICP metals consists of a method blank and 3 calibration standards.

B. The validity of the initial calibration is verified by the analysis of an independently prepared standard immediately after calibration.

C. Results must be within 90% to 110% of true value for each metal analyzed for analysis to begin.

D. Continuing calibration is performed by analysis of the Calibration Check Verification (CCV) standard at a frequency of 10% of sample volume, or every 2 hours, whichever is more frequent. The concentration of the CCV is at or near the mid-range of the calibration curve for each metal. The CCV is also analyzed after the last analytical sample. The validity of the calibration and analysis of preceding samples is verified by CCV results between 90% of 110% of true value.

E. Standards Preparation Procedures

Calibration Standards

- Prepare calibration standards by dilution of the stock standard.

- The calibration standards are prepared in reagent grade water, with the same acid concentrations as the digested sample.

8.3 Conventional Wet Chemistry

A. For manual colorimetric analytical procedure an initial five standard calibration curve must be generated every three months, with a reagent blank and a continuing calibration standard being run with every sample batch. If the concentration of the continuing calibration standard, as calculated from the initial calibration curve, exceeds ± 10% of the theoretical concentration then that batch of samples must be rerun. If the rerun still exceeds ± 10%, then the system should be considered out of control and a new initial calibration curve must be generated.

9.0 Analytical Procedures

The analytical procedures to be used in the analysis of samples will utilize the following references:

EPA 8260C (2)
EPA 200.7 (1)
EPA 200.8 (1)
SM18 2540C (3)
SM18 4500OC (3)
EPA 300 (1)

References

1.0 "Methods for Chemical Analysis of Water and Wastewater", EPA-600/4-79-020, March 1983.
2.0 "Methods for the Determination of Organic Compounds in Drinking Water EPA/600/4-88/039, December 1988.
3.0 "Standard Methods for the Examination of Water and Wastewater", 18th Edition, 1992, pp. 4-115.
4.0 "Prescribed Procedures for the Measurement of Radioactivity in Drinking Water", EPA, Environmental Support and Monitoring Laboratory, Cincinnati, OH. EPA-600/4-80-032, August 1980.

Table 7 Education and Experience

Douglas Tawse – MBA Business Administration, University of New Hampshire, Durham, NH; B.A. Business Administration, University of New Hampshire, Durham, NH
Responsibilities: President
Experience: Over 30 years in the Environmental and Business Field

Ronald Bayer – M.S., Environmental Sciences, Syracuse University, B.A., Chemistry, SUNY at Cortland
Responsibilities: VP Operations
Experience: Over 30 years in the Environmental and Business Field.

Renee M. Cusack – B.S., Biology, Mount Saint Mary College, NY
Responsibilities: Laboratory Director
Experience: Over 30 years in the Environmental Field

Kevin Jowell - B.S. Information Technology, University of Phoenix, AZ
Responsibilities: Information Technology, Operations
Experience: 10 years I.T., 5 years analytical

Maria Pistole - B.S. Biology, Minor Chemistry, Marist College, NY
Responsibilities: Quality Manager, Inorganic Supervisor
Experience: Over 25 years Environmental Field, 12 years EnviroTest

Debra R. Bayer – A.A.S. Management, SUNY Delhi, NY
Responsibility: Customer Service Manger
Experience: Over 20 years

Eric Andersen – M.A. Chemistry, SUNY New Paltz, NY; B.S. Chemistry, Southampton College of Long Island University, NY
Responsibilities: Organics Manager
Experience: Over 25 years

Joyce M. Wilson-Esposito – High School Graduate
Responsibilities: Customer Service
Experience: Over 20 years

Alicia Labare – B.S. Chemistry, SUNY at Plattsburgh, NY
Responsibilities: Organics
Experience: 9 years analytical, 13 years EnviroTest

Meredith Ruthven – B.A. Biology, University of Vermont, Burlington, VT
Responsibilities: Customer Service
Experience: 13 years Environmental Field, 2 year Pharmaceutical, 9 years EnviroTest.

Laura Antash – Attended Dutchess Community College, NY and Orange County Community College, NY
Responsibilities: Sample Receipt Technician
Experience: 15 years Environmental Field, 11 years EnviroTest

Paul Pullar – B.A. Biology, Franklin Pierce College, Rindge, NH
Responsibilities: Organics, Environmental Health and Safety
Experience: 21 years Environmental Field

Gus Palentino – B.A. Biology, Marist College, New York
Responsibilities: Organics, Metals
Experience: Over 30 years environmental

Richard Bayer – Grade III Wastewater Operator, High School Graduate
Responsibilities: Field Service
Experience: 25 years Field Supervisor, EnviroTest

Mark Brignola - B.S.Community Health Education; B.S. Health Science, Minor Biology
Responsibilities: Field Service
Experience: 11 years EnviroTest

Kyle Miller - B.A. Environmental Science, Franklin Pierce College, N.H.
Responsibilities: Organics, Field Service
Experience: 6 years EnviroTest

Tracy Gualtieri - High School Graduate
Responsibilities: Office Manager/Receptionist/Accounts Receivable/ Customer Service
Experience: 20 years, 4 years EnviroTest

Janine Rader – High School Graduate
Responsibilities: Administrative General Accounting
Experience: 4 years accounting, 13 years data entry

Ian Mawe – MSc Security Studies, University College London, UK
BSc Gonvernment, University College Cork, Ireland
Responsibilities: Microbiology

Diana Algarin - 1 year Mount Saint Mary; 1 year Mercy College, New York
Responsibilities: Sample Management
Experience: 6 years

Table 8 Facilities and Equipment

5.1 Instrumentation

Instrument Type	Manufacturer	Model	Purchase Date	Autosampler	Method Performed
ICP	Perkin Elmer S/N 069N9012702	3300XL Optima Trace		Yes	6010B, 200.7
	Thermo Scientific S/N 20113414	ICAP 6500 Trace	2011	Yes	6010B, 200.7
ICP/MS	Perkin Elmer Sciex S/N P1610402	ELAN 9000	2004	Yes	6020, 200.8
Mercury Analyzer	Leeman S/N2012112-00064-1	Hydra AA	2002	Yes	7471A, 7470, 245.1
Ion Chromatograph	Dionex S/N 01031371	DX-120		Yes	300.0
TOC	OI Analytical S/N J236710839	1010	2002	Yes	5310C
TKN Digestion System	LACHAT Instruments Block Digestor S/N 1800-763	BD-46	2003	No	LAC 10-107-062D 351.2
UV/VIS	Thermo Spectronic S/N 3SGD117031	Genesys 20	1996	No	HACH 8000, 4500NO2B, 4500CN-E, 3500CR-D, 5540C, 4500PE, 365.3, 4500S2-D
Flow Injection System	Lachat S/N 050600000176	Quick Chem 8500	2006	Yes	LAC 10-107-04-1C, LAC 10-210-00-1-A, LAC 10-204-00-1-A, 351.2

Autotitrator (pH, Alkalinity, turbidity, calcium hardness	Man-Tech (ATZ) S/N MS-OEI-582, Titration Module S/N MS-OBI-278, Buret Meter port	PC – Titrate PC-1000	2003	Yes	4500HB, 2320B
pH Meter	Fisher S/N 5228013	Accumet Meter		No	4500HB, 9045C
	Thermo Scientific S/N B27499	Orion 2 Star		No	4500HB, 9045C
Turbidimeter	HACH s/n 07120C023206	2100N	2008	No	2130B
Turbidimeter	HACH S/N 890320055	2100A		No	2130B
Conductivity Meter	Thermo Orion S/N 063635	Model 150 A+		No	2510B
Automated Distillation Apparatus	Westco S/N 1111	Easy Digest 40/20	2003	No	4500NH3, Phenol, LACHAT 10-210-001A
COD Reactor	HACH S/N 1159604	DRB 200	2006	No	410.4, HACH 8000
COD Reactor	HACH S/N 1122144	DRB 200	2005	No	410.4, HACH 8000
Automated BOD Analyzer	Mandel Scientific Instruments S/N 164334 DO Meter S/N 07C1245	BOD Magic/YSI 5100		No	5210B
Auotclave	Market Forge S/N 163569	Sterilmatic			365.3
Hot Block Digestor	Environmental Express		1998	No	3005A, 3010A, 3020A
	Environmental Express		1998	No	3005A, 3010A, 3020A
Utrasonic Processor	Misonic S/N G2771	XL-2020		No	95.3
Auto Shaker	Glas-Col S/N 279668	3D-Shaker		No	Extractions
GC/MS Volatiles	Hewlett-Packard MSD S/N 3022A29134	5970		Yes	524/624/8260
GC/MS SemiVolatiles	Hewlett-Packard MS3 S/N US00006787	5972		Yes	8270/625
GC/MS SemiVolatiles	Hewlett-Packard MS7 S/N 1-4897967882	5975		Yes	8270/625

GC/MS Volatiles	Hewlett-Packard MS4 S/N CN10803090	5975	2008	Yes	524/624/8260
GC Volatiles	Hewlett-Packard (A) S/N 3033A32718 GC1	5890A Dual FID		Yes	8015 m-pyrol Gylcol
	Hewlett-Packard S/N 2443A03968 GC2	5890 FID		Yes	8015 Alcohols, Amines
	Hewlett-Packard S/N 3203A42081 GC 3	ECD		Yes	552.2
GC Volatiles	OI Analytical S/N US00003177 GC 5	6890 ELCD/PID		Yes	502.2/8021 601/602
	Hewlett Packard S/N 3022A28968 GC 6	5890 PID/FID		Yes	602 8021Stars/502.2 PID only
	Hewlett-Packard (J) S/N 3336A61811 GC 4	5890A PID/ELCD		Yes	8021/502.2/601/602
	OI Analytical S/N US10343086 GC 7	6890 ELCD/PID		Yes	502.2/8021 601/602
	OI Analytical S/N US10402016 GC 8	6890 ELCD/PID		Yes	502.2/8021 601/602
Turbo Vap.	Horizon Technology SN-02-0403	Speed Vap II 9000			1664

Laboratory Information Management System

- EnviroTest's LIMS runs on the .Net framework and utilizes the Microsoft SQL Server technologies for secure day to day data operations.

  The environmental conditions of the facility housing the central servers are controlled to protect against data loss. Access to the central server room is restricted to the IT staff. The central computer room is temperature controlled, and has multiple Uninterrupted Power Supplies (UPSs) to ensure that the network functions are not disrupted by power failures. Backup media, such as tapes and disks, are maintained daily.

  Records for the system architecture, testing and maintenance, are stored onsite in the server room. Records for installation of the network hardware are maintained by the Technology Director. This system is administered and maintained by ETL IT staff.

- The local systems consist of computer equipment for analytical instruments, data evaluation, and upload to the LIMS. A local-area network (LAN) supports the local office software. The LIMS is comprised of three servers. One of the servers controls all internal LIMS applications. A second server stores all generated reports and electronic deliverables and is also utilized as the import server. A third server houses the LIMS SQL Server database. All documentation pertaining to the LIMS servers –

the repair preventive maintenance or modification thereof - are the responsibility of the EnviroTest Technology Specialist. The laboratory has approximately 50 computers connected to the LAN. Most are workstations, many are running instruments, and a few are laptops.

TABLE 10 REQUIRED CONTAINER TYPE AND HOLDING TIMES

				PRESERVATION			**HOLDING TIME**		
Parameter	**Bottle Type**	**Vol. Ml**	**Wt. G**	**DW**	**WW/ GW**	**Solid Waste**	**DW**	**WW/ GW**	**Solid Waste**
Metals	P	500	50	NHO3 to pH<2	NHO3 to pH<2	4C	6months	6months	6months
VOA, 8260	G TFE Cap	4x40	Terra Core or Encore Sampler	HCl to pH<2, 4C	HCl to pH<2, 4C	Sample Specifi	14 Days	14 Days	48 Hours to freeze 14 Days analysis
Solids, total dissolved	P,G	250	NA	4C	4C	4C	7 days	7 days	N/A
Hardness	P,G	250	50	NHO3 or H2sO4 to pH<2	NHO3 or H2sO4 to pH<2		14 Days		14 Days
Nitrate (as N)	P,G	250	50	4C	4C	NA	48 Hours	48 Hours	NA
Dissolved Oxygen	P, Glass Stopper	300	NA	HACH Manganous Sulfate Powder Pillows & HACH Alkaline Iodide-Azide Reagent Powder pillows	HACH Manganous Sulfate Powder Pillows & HACH Alkaline Iodide-Azide Reagent Powder pillows	NA	8 Hours	8 Hours	NA

STANDARD OPERATING PROCEDURE

1.0 PROCEDURE TITLE: Volatile Organic Compounds by Gas Chromatography/Mass Spectrometry (GC/MS)

Approvals and Signatures

Laboratory Director: Brian Cusack Date: 9/18/13

QA Manager: (Assistant) Date: 9/18/13

Section Supervisor Date: 9/18/13

EH&S Officer Date: 9/18/13

Control #: 54

2.0 AREA OF APPLICABILITY: Volatile Organics

3.0 SCOPE AND APPLICATION:

Method 8260 is used to determine volatile organic compounds in a variety of aqueous and solid waste matrices. This method is applicable to nearly all types of samples, regardless of water content, including various air sampling trapping media, ground and surface water, aqueous sludges, caustic liquors, acid liquors, waste solvents, oily wastes, mousses, tars, fibrous wastes, polymeric emulsions, filter cakes, spent carbons, spent catalysts, soils, and sediments. The reportable detection limit is 1ug/l for waters and 1ug/kg for soils (wet weight) unless otherwise stated in table below.

Analyte	Reporting limit ug/L	Analyte	Reporting limit ug/L
Dichlorodifluoromethane	1	trans-1,3-Dichloropropene	1
Chloromethane	1	1,1,2-Trichloroethane	1
Vinyl Chloride	1	Chloroacetonitrile	10
Bromomethane	1	1,3-Dichloropropane	1
Chloroethane	1	Dibromochloromethane	1
Acrolein	2	Ethyl methacrylate	5
Acetonitrile	1	1,2-Dibromoethane	1
Acrylonitrile	1	Bromoform	1

Trichlorofluoromethane	1	4-Methyl-2-Pentanone	5
Analyte	**Reporting limit ug/L**	**Analyte**	**Reporting limit ug/L**
Diethyl ether	1	2-Hexanone	5
FREON 123A	1	Toluene	1
FC-113	1	Tetrachloroethene	1
Acetone	5	1,1,1,2-Tetrachloroethane	1
IPA	10	Chlorobenzene	1
Allyl chloride	1	1-Chlorohexane	1
Iodomethane	1	Ethylbenzene	1
1,1-Dichloroethene	1	m,p-Xylene	2
Methylene Chloride	1	Styrene	1
Carbon Disulfide	1	o-Xylene	1
trans-1,2-Dichloroethene	1	1,1,2,2-Tetrachloroethane	1
MTBE	1	1,2,3-Trichloropropane	1
1,1-Dichloroethane	1	trans-1,4-Dichloro-2-butene	1
Vinyl Acetate	1	Isopropylbenzene	1
2-Butanone	5	Bromobenzene	1
cis-1,2-Dichloroethene	1	n-Propylbenzene	1
Bromochloromethane	1	2-Chlorotoluene	1
Chloroform	1	4-Chlorotoluene	1
2,2-Dichloropropane	1	1,3,5-Trimethylbenzene	1
Methyl acrylate	5	Pentachloroethane	1
Tetrahydrofuran	1	tert-Butylbenzene	1
1,2-Dichloroethane	1	1,2,4-Trimethylbenzene	1
1,1,1-Trichloroethane	1	sec-Butylbenzene	1
1-Chlorobutane	1	1,3-Dichlorobenzene	1
1,1-Dichloropropene	1	Benzyl chloride	1
Carbon Tetrachloride	1	1,4-Dichlorobenzene	1
Benzene	1	4-Isopropyltoluene	1
Dibromomethane	1	1,2-Dichlorobenzene	1
1,2-Dichloropropane	1	n-Butylbenzene	1
Trichloroethene	1	1,2-Dibromo-3-chloropropane	1
Bromodichloromethane	1	Hexachloroethane	1
2-Nitropropane	10	1,2,4-Trichlorobenzene	1

1,4-Dioxane	50	Naphthalene	1
Analyte	**Reporting limit ug/L**	**Analyte**	**Reporting limit ug/L**
Methyl methacrylate	5	Hexachlorobutadiene	1
2-Chloroethylvinylether	1	TBA, tert Butyl Alcohol	10
cis-1,3-Dichloropropene	1	1,2,3-Trichlorobenzene	1
Chloroprene	1	Propionitrile	8
Methacrylonitrile	1	Isobutyl alcohol	10

3.1 Use of this method is restricted to use by, or under supervision of, personnel appropriately experienced and trained in the use of gas chromatograph/mass spectrometers and skilled in the interpretation of mass spectra. Each analyst must demonstrate the ability to generate acceptable results with this method.

3.2 Analysts using this method must also refer to SOP-CIP-1, Chromatographic Integration Procedures.

4.0 PRINCIPLE: The volatile compounds are introduced into the gas chromatograph by the purge-and-trap method (5030 or 5035). The analytes are introduced from the effluent of a trap into an injection port operating in a split mode for injection onto a narrow bore capillary column. The column is temperature-programmed to separate the analytes, which are then detected with a mass spectrometer (MS) interfaced to the gas chromatograph (GC). Analytes eluted from the capillary column are introduced directly into the mass spectrometer. Identification of target analytes is accomplished by comparing their mass spectra with the electron impact (or electron impact-like) spectra of authentic standards. Quantitation is accomplished by comparing the response of a major (quantitation) ion relative to an internal standard using a five or more point calibration curve.

5.0 REFERENCES

5.1 “Test Methods for Evaluating Solid Waste”,USEPA-SW846, Third Edition, September 1986 with all current revisions, method 8260C.
5.2 “Test Methods for Evaluating Solid Waste”,USEPA-SW846, Third Edition, September 1986 with all current revisions, method 8000C.
5.3 EPA Method 624, 40 CFR Part 136, Appendix A, revised as of July 1, 1995.
5.4 EPA Method 5035A, Draft Revision 1, July 2002.

6.0 PRESERVATION AND HOLD TIME

6.1 Samples should be stored in capped bottles, with no headspace, at 6°C or less in an area free of solvent fumes.
6.2 All samples should be analyzed within 14 days of collection.
6.3 Samples not analyzed within this period must be noted and data are considered minimum values.
6.4 The pH of all samples will be checked using pH paper and recorded.

6.5 Acrolein has a hold time of 3 days.

6.6 Soil samples are to be collected as per method 5035A (Low and High level).

6.6.1 5035A-L, Low level soil collection: 5 grams of soil are collected in duplicate in the field and immediately extruded into a lab supplied pre weighed vial containing 5 mls of organic free water and a stir bar. The samples will be transported to the lab on ice and frozen on arrival until analysis. Sample holding time is 14 days from collection. A separate container of soil will be collected for percent solid analysis.

6.6.2 5035A-H, High level soil collection: 5 grams of soil will be collected and extruded into a pre weighed vial containing 5 mls of methanol. The sample will be immediately cooled to 4+/- 2°C and transported to the lab. Sample holding time is 14 days from collection. A separate container of soil will be collected for percent solids analysis.

6.6.3 If requested three Encore samplers will be provided by the laboratory for field sample collection instead of vials. The Encores will be immediately cooled to 4+/- 2°C and transported to the lab. Two of the Encores will be extruded per section 6.6.1 and the third by 6.6.2. A separate container of soil will be collected for percent solid analysis.

7.0 INTERFERENCES

7.1 Major contaminant sources are volatile materials in the laboratory and impurities in the inert purging gas and in the sorbent trap. The laboratory where the analysis is to be performed should be free of solvents other than water and methanol. Many common solvents, most notably acetone and methylene chloride, are frequently found in laboratory air at low levels. The sample receiving chamber should be loaded in an environment that is clean enough to eliminate the potential for contamination from ambient sources. In addition, the use of non-PTFE thread sealants, plastic tubing, or flow controllers with rubber components should be avoided, since such materials out-gas organic compounds which will be concentrated in the trap during the purge operation. Analyses of calibration and reagent blanks provide information about the presence of contaminants. Subtracting blank values from sample results is not permitted. If reporting values for situations where the laboratory feels is a false positive result for a sample, the laboratory should fully explain this in text accompanying the uncorrected data and / or include a data qualifier that is accompanied with an explanation.

7.2 Contamination may occur when a sample containing low concentrations of volatile organic compounds is analyzed immediately after a sample containing high concentrations of volatile organic compounds. A technique to prevent this problem is to rinse the purging apparatus and sample syringes with two portions of organic-free reagent water between samples. After the analysis of a sample containing high concentrations of volatile organic compounds, one or more blanks should be analyzed to check for cross-contamination. Alternatively, if the sample immediately following the high concentration sample does not contain the volatile organic compounds present in the high level sample, freedom from contamination has been established.

7.3 For samples containing large amounts of water-soluble materials, suspended solids, high boiling compounds, or high concentrations of compounds being determined, it may be necessary to wash the purging device with a soap solution, rinse it with organic-free reagent water, and then dry the purging device in an oven at 105°C. In extreme situations, the entire purge-and-trap device may require dismantling and cleaning. Screening of the samples prior to purge-and-trap GC/MS analysis is highly recommended to prevent contamination of the system. This is especially true for soil and waste samples. Screening may be accomplished with an automated headspace technique (Method 5021) or by Method 3820 (Hexadecane Extraction and Screening of Purgeable Organics).

7.4 Many analytes exhibit low purging efficiencies from a 25-mL sample. This often results in significant amounts of these analytes remaining in the sample purge vessel after analysis. After removal of the sample aliquot that was purged, and rinsing the purge vessel three times with organic-free water, the empty vessel should be subjected to a heated purge cycle prior to the analysis of another sample in the same purge vessel. This will reduce sample-to-sample carryover.

7.5 Special precautions must be taken to analyze for methylene chloride. The analytical and sample storage area should be isolated from all atmospheric sources of methylene chloride. Otherwise, random background levels will result. Since methylene chloride will permeate through PTFE tubing, all gas chromatography carrier gas lines and purge gas plumbing should be constructed from stainless steel or copper tubing. Laboratory clothing worn by the analyst should be clean, since clothing previously exposed to methylene chloride fumes during liquid/liquid extraction procedures can contribute to sample contamination.

7.6 Samples can be contaminated by diffusion of volatile organics (particularly methylene chloride and fluorocarbons) through the septum seal of the sample container into the sample during shipment and storage. A trip blank prepared from organic-free reagent water and carried through the sampling, handling, and storage protocols can serve as a check on such contamination.

7.7 Use of sensitive mass spectrometers to achieve lower detection level will increase the potential to detect laboratory contaminants as interferences.

7.8 Direct injection - Some contamination may be eliminated by baking out the column between analyses. Changing the injector liner will reduce the potential for cross-contamination. A portion of the analytical column may need to be removed in the case of extreme contamination. The use of direct injection will result in the need for more frequent instrument maintenance.

8.0 APPLICABLE/ASSOCIATED SOPS

8.1 SAFETY

8.1.1 Employees must abide by the policies and procedures in the Corporate Safety Manual, Radiation Safety Manual, Waste Management SOP and this document

8.1.2 SPECIFIC SAFETY CONCERNS OR REQUIREMENTS

8.1.2.1 The gas chromatograph and mass spectrometer contain zones that have elevated temperatures. The analyst needs to be aware of the locations of those zones, and must cool them to room temperature prior to working on them.

8.1.2.2 The mass spectrometer is under deep vacuum. The mass spectrometer must be brought to atmospheric pressure prior to working on the source.

8.1.2.3 There are areas of high voltage in both the gas chromatograph and the mass spectrometer. Depending on the type of work involved, either turn the power to the instrument off, or disconnect it from its source of power.

8.1.3 PRIMARY MATERIALS USED

8.1.3.1 The following is a list of the materials used in this method, which have a serious or significant hazard rating. NOTE: This list does not include all materials used in the method. The table contains a summary of the primary hazards listed in the MSDS for each of the materials listed in the table. A complete list of materials used in the method can be found in the reagents and materials section. Employees must review the information in the MSDS for each material before using it for the first time or when there are major changes to the MSDS.

Material (1)	**Hazards**	**Exposure Limit (2)**	**Signs and symptoms of exposure**
Hydrochloric Acid	Corrosive Poison	5 ppm-Ceiling	Inhalation of vapors can cause coughing, choking, inflammation of the nose, throat, and upper respiratory tract, and in severe cases, pulmonary edema, circulatory failure, and death. Can cause redness, pain, and severe skin burns. Vapors are irritating and may cause damage to the eyes. Contact may cause severe burns and permanent eye damage.
Methanol	Flammable Poison Irritant	200 ppm-TWA	A slight irritant to the mucous membranes. Toxic effects exerted upon nervous system, particularly the optic nerve. Symptoms of overexposure may include headache, drowsiness and dizziness. Methyl alcohol is a defatting agent and may cause skin to become dry and cracked. Skin absorption can occur; symptoms may parallel inhalation exposure. Irritant to the eyes.
1 – Always add acid to water to prevent violent reactions.			
2 – Exposure limit refers to the OSHA regulatory exposure limit.			

8.2 WASTE MANAGEMENT AND POLLUTION PREVENTION

8.2.1 All waste will be disposed of in accordance with Federal, State and Local regulations. Where reasonably feasible, technological changes have been implemented to minimize the potential for pollution of the environment. Employees will abide by this method and the policies in section 13 of the Corporate Safety Manual for "Waste Management and Pollution Prevention."

8.2.2 Waste Streams Produced by the Method

8.2.2.1 The following waste streams are produced when this method is carried out.

8.2.2.1.1 Aqueous waste generated from analysis. This material may have a pH < 2.0. (Discard the waste down an acid neutralizing sink).

8.2.2.1.2 Solvent waste generated from analysis. Discard into methanol solvent waste container.

8.2.2.1.3 Solid waste generated from analysis. Discard into solid waste container for pick up by waste disposal company.

8.2.2.1.4 Expired Standards. Standards are given to the EH&S Officer who stores them until picked up by the Waste Disposal Company.

9.0 PROCEDURE

9.1 Apparatus

- 9.1.1 Purge-and-trap device for aqueous samples.(OI 4560 concentrator with an OI DPM 16 or OI 4552 auto sampler)
- 9.1.2 Purge-and-trap device for solid samples (OI 4560 concentrator with an OI 4552 auto sampler)
- 9.1.3 Injection port liners (HP Catalog #18740-80200, or equivalent)
  - 9.1.3.1 A 0.53-mm ID column is mounted 1 cm into the liner from the oven side of the injection port, according to manufacturer's specifications.
- 9.1.4 Gas chromatography/mass spectrometer/data system
  - 9.1.4.1 Gas chromatograph - An analytical system complete with a temperature-programmable gas chromatograph suitable for splitless injection with appropriate interface for sample introduction device. The system includes all required accessories, including syringes, analytical columns, and gases.
  - 9.1.4.2 The GC should be equipped with variable constant differential flow controllers so that the column flow rate will remain constant throughout desorption and temperature program operation.
  - 9.1.4.3 The capillary column is interfaced directly into Mass Spectrometer, depending on the size of the capillary and the requirements of the GC/MS system.
- 9.1.5 Gas chromatographic columns
  - 9.1.5.1 Column 1 - 30 - 75 m x 0.53 mm ID capillary column coated with DB-624 (J&W Scientific), Rt-502.2(RESTEK)
  - 9.1.5.2 Column 2 – 20m x 0.18 mm ID, 1um DB-VRX
  - 9.1.5.3 Column 3 – 30-75 m x 0.53 um x 3um film thickness VOCOL (Supelco), or equivalent.
- 9.1.6 Mass spectrometer
  - 9.1.6.1 Capable of scanning from 35 to 270 amu every 1 sec or less, using 70 volts (nominal) electron energy in the electron impact ionization mode.
  - 9.1.6.2 The mass spectrometer must be capable of producing a mass spectrum for 4-Bromofluorobenzene (BFB) which meets all of the criteria in QC section when 5-50 ng of the GC/MS tuning standard (BFB) are injected through the GC.
  - 9.1.6.3 To ensure sufficient precision of mass spectral data, the desirable MS scan rate allows acquisition of at least five spectra while a sample component elutes from the GC.
  - 9.1.6.4 GC/MS interface - A jet separator, including an all-glass transfer line and glass enrichment device or split interface.
- 9.1.7 Data system
  - 9.1.7.1 A computer system that allows the continuous acquisition and storage on machine-readable media of all mass spectra

obtained throughout the duration of the chromatographic program must be interfaced to the mass spectrometer.

9.1.7.2 The computer must have software that allows searching any GC/MS data file for ions of a specified mass and plotting such ion abundances versus time or scan number.

9.1.7.3 Software must also be available that allows integrating the abundances in any EICP between specified time or scan-number limits.

9.1.7.4 The most recent version of the EPA/NIST Mass Spectral Library should also be available.

9.1.8 Microsyringes - 10-, 25-, 100-, 250-, 500-, and 1,000-µL.

9.1.9 Syringes with Luer ends, 5,10, and 25ml (three each).

9.1.10 Balance - Analytical, capable of weighing 0.0001 g, and top loading, capable of weighing 0.1 g.

9.1.11 Glass vials - 40-mL, with PTFE-lined screw-caps or glass culture tubes with PTFE-lined screw-caps.

9.1.12 Disposable pipets - Pasteur.

9.1.13 Volumetric flasks, Class A – 10 ml 50-mL and 100-mL, with ground-glass stoppers.

9.1.14 Spatula - Stainless steel.

9.2 Reagents

9.2.1 Reagent grade inorganic chemicals shall be used in all tests. Unless otherwise indicated, it is intended that all inorganic reagents shall conform to the specifications of the Committee on Analytical Reagents of the American Chemical Society, where such specifications are available.

9.2.2 Organic-free reagent water - All references to water in this method refer to organic-free reagent water.

9.2.3 Methanol, CH OH – Purge and Trap Grade or equivalent, demonstrated to be free of analytes. Store apart from other solvents.

9.2.4 Hydrochloric acid (1:1 v/v), HCl - Carefully add a measured volume of concentrated HCl to an equal volume of organic-free reagent water.

9.2.5 Stock solutions - Stock solutions are prepared from pure standard materials or purchased as certified solutions. Prepare stock standard solutions in methanol.

9.2.5.1 Transfer the stock standard solution into a bottle with a PTFE-lined screw-cap. Store, with minimal headspace and protected from light, at 6° C or less or as recommended by the standard manufacturer.

9.2.5.2 Standards should be returned to the freezer as soon as the analyst has completed mixing or diluting the standards to prevent the evaporation of volatile target compounds.

9.2.6 Frequency of Standard Preparation

9.2.6.1 Standards for the permanent gases and non-gases should be monitored frequently by comparison to the initial calibration curve.

9.2.6.2 Fresh standards should be prepared if this check exceeds a 20% drift.

9.2.7 Secondary dilution standards - Using stock standard solutions prepare secondary dilution standards in methanol containing the compounds of interest, either singly or mixed together.

9.2.7.1 Secondary dilution standards must be stored with minimal headspace and should be checked frequently for signs of degradation or evaporation, especially just prior to preparing calibration standards from them.

9.2.7.2 Store in a vial with no headspace.

Replace after two to four weeks, one week for gases unless the acceptability of the standard can be documented.

9.2.7.3 Then using premixed certified solutions, store according to the manufacturer's documented holding time and storage temperature recommendations.

9.2.8 Surrogate standards: The surrogate standards are toluene-d8, 4-bromofluorobenzene, and 1,2-dichloroethane-d4.

9.2.8.1 See internal standards and surrogates table below. Each sample undergoing GC/MS analysis must be spiked with the surrogate spiking solution prior to analysis.

9.2.9 Internal standards - The internal standards are fluorobenzene, chlorobenzene-d5, and or bromochloromethane (or 1,4-diflurorbenzene). Other internal standards may be used as long as they have retention times similar to the compounds being detected by GC/MS.

9.2.9.1 Area counts of the internal standard peaks will be between 50-200% of the areas of the target analytes in the mid-point calibration analysis.

9.2.10 Bromofluorobenzene (BFB) standard - A standard solution containing 50 ng/µL of BFB in methanol will be prepared.

9.2.11 Calibration standards –Store initial and continuing calibration standards according to the manufacturers instructions.

Aqueous standards are not stable and should be prepared daily.

9.2.11.1 Initial calibration standards should be prepared at a minimum of five different concentrations from a premixed certified solution. Prepare these solutions in organic-free reagent water.

9.2.11.2 At least one of the calibration standards should correspond to a sample concentration at or below that necessary to meet the data quality objectives of the project.

9.2.11.3 The remaining standards should correspond to the range of concentrations found in typical samples but should not exceed the linear range of the instrument.

9.2.11.4 Continuing Calibration standards are prepared at a concentration near the mid-point of the initial calibration range from a premixed certified solution. Prepare these solutions in organic-free reagent water.

9.2.11.5 See the following table for standard preparation:

Table 1: Primary and Second Source Standard instructions

Mix ID	Standard Name	Standard Concentration	Amount Used	Final Volume	Final Concentration
GASES std @ 100 ppm	Restek 502.2 Mix #1	2000 ug/ml	150 uL	3.0 mL	100 ug/mL
	TBA (tert Butyl Alcohol)	50000 ug/ml	40 Ul		1000 ug/mL
	IPA	20000 ug/mL	150 uL		1000 ug/mL
	Methanol		2660 uL		
GASES std @ 10 ppm	GASES std @ 100 ppm	100 ug/mL	200 uL	2.0 mL	10 ug/mL
	Methanol		1800 uL		

Primary Volatile Standards

Mix ID	Standard Name	Standard Concentration	Amount Used	Final Volume	Final Concentration
8260/624/524.2 std @ 100 ppm	Restek 524.2 Mega Mix #3061	2000 µg/mL	150 µL	3.0 mL	100 ug/mL
	Restek Ketone mix #30006	5000 µg/mL	60 µL		100 ug/mL
	Acrolein #30645	5000 µg/mL	120 µL		200 ug/mL
	Vinyl Acetate #30216	2000 µg/mL	150 µL		100 ug/mL
	Restek Custom mix # 563762	2000 µg/mL	150 µL		100 ug/mL
	Restek Custom Mix #564040	2000 ug/mL	150 uL		100 ug/mL
	Restek 1,4-Dioxane # 30287	2000 ug/ml	750 uL		500 ug/mL
	Methanol		1620 uL		
8260/624/524.2 std @ 10 ppm	8260/624/524.2 std @ 100 ppm	100 ug/mL	200 uL	2.0 mL	10 ug/mL
	Methanol		1800 uL		

MS VOA Water Curve

Calibration Level	Standard Used	Amount Used	Final Volume (water)	Final Concentration
0.5 ppb	524.2/8260/624 STD @ 10ppm	**2.5 µL**	50 mL	0.5 µg/L
	GASES STD @ 10ppm	**2.5 µL**		0.5 µg/L
	Surrogate @ 10ppm	**2.5 µL**		0.5 µg/L
2 ppb	524.2/8260/624 STD @ 10ppm	**10 µL**	50 mL	2 µg/L
	GASES STD @ 10ppm	**10 µ L**		2 µg/L
	Surrogate @ 10ppm	**10 µL**		2 µg/L
5 ppb	524.2/8260/624 STD @ 10ppm	**25 µL**	50 mL	5 µg/L
	GASES STD @ 10ppm	**25 µL**		5 µg/L
	Surrogate @ 10ppm	**25 µL**		5 µg/L
10 ppb	524.2/8260/624 STD @ 100ppm	**5 µL**	50 mL	10 µg/L
	GASES STD @ 100ppm	**5 µL**		10 µg/L
	Surrogate @ 100ppm	**5 µL**		10 µg/L
20 ppb	524.2/8260/624 STD @ 100ppm	**10 µL**	50 mL	20 µg/L
	GASES STD @ 100ppm	**10 µL**		20 µg/L
	Surrogate @ 100ppm	**10 µL**		20 µg/L
50 ppb	524.2/8260/624 STD @ 100ppm	**25 µL**	50 mL	50 µg/L
	GASES STD @ 100ppm	**25 µL**		50 µg/L
	Surrogate @ 100ppm	**25 µL**		50 µg/L
100 ppb	524.2/8260/624 STD @ 100ppm	**50 µL**	50 mL	100 µg/L
	GASES STD @ 100ppm	**50 µL**		100 µg/L
	Surrogate @ 100ppm	**50 µL**		100 µg/L

GC VOA Soil Curve

Calibration Level	Standard Used	Amount Used	Final Volume (water)	Final Concentration
1 ppb	524.2/8260/624 STD @ 10ppm	**0.5 µL**	5 mL	1 µg/L
	GASES STD @ 10ppm	**0.5 µL**		1 µg/L
	Surrogate @ 10ppm	**0.5 µL**		1 µg/L
2 ppb	524.2/8260/624 STD @ 10ppm	**1 µL**	5 mL	2 µg/L
	GASES STD @ 10ppm	**1 µL**		2 µg/L
	Surrogate @ 10ppm	**1 µL**		2 µg/L
5 ppb	524.2/8260/624 STD @ 10ppm	**2.5 µL**	5 mL	5 µg/L
	GASES STD @ 10ppm	**2.5 µL**		5 µg/L
	Surrogate @ 10ppm	**2.5 µL**		5 µg/L
10 ppb	524.2/8260/624 STD @ 100ppm	**0.5 µL**	5 mL	10 µg/L
	GASES STD @ 100ppm	**0.5 µL**		10 µg/L
	Surrogate @ 100ppm	**0.5 µL**		10 µg/L
20 ppb	524.2/8260/624 STD @ 100ppm	**1 µL**	5 mL	20 µg/L
	GASES STD @ 100ppm	**1 µL**		20 µg/L
	Surrogate @ 100ppm	**1 µL**		20 µg/L
50 ppb	524.2/8260/624 STD @ 100ppm	**2.5 µL**	5 mL	50 µg/L
	GASES STD @ 100ppm	**2.5 µL**		50 µg/L
	Surrogate @ 100ppm	**2.5 µL**		50 µg/L
100 ppb	524.2/8260/624 STD @ 100ppm	**5 µL**	5 mL	100 µg/L
	GASES STD @ 100ppm	**5 µL**		100 µg/L
	Surrogate @ 100ppm	**5 µL**		100 µg/L

Internal Standards and Surrogates

Prepare the following internal standards and surrogate mix. The final volume is 1ml.

Stock standard Name	Concentration of Stock standard (ug/ml)	Volume of stock (ul)
Fluorobenzene Internal Std	2000	50
Chlorobenzene-d5 Internal Std.	2000	50
Restek Surrogate	2500	40
Methanol		1860

Add 5 ul of this solution to each sample prior to analysis.

Note: It is the intent of EPA that all target analytes for a particular analysis be included in the initial calibration and calibration verification standard(s). These target analytes may not include the entire list of analytes for which the method has been demonstrated. However, the laboratory shall not report a quantitative result for a target analyte that was not included in the calibration standard(s).

9.2.11.6 The calibration standards must also contain the internal standards chosen for the analysis.

9.2.12 Matrix Spike and Blank spike standards - Matrix spiking and blank spike standards will be prepared from volatile organic compounds which are representative of the compounds of interest. The standard should be prepared in methanol, with each compound present at a concentration near mid point of the curve.

9.2.12.5 The matrix spike (MS) and laboratory control standards (LCS) should be from the same source as the initial calibration standards to restrict the influence of accuracy on the determination of recovery throughout preparation and analysis. Matrix spiking and LCS standards should be prepared from volatile organic compounds which are representative of the compounds being investigated. At a minimum, the matrix spike should include 1,1-dichloroethene, trichloroethene, chlorobenzene, toluene, and benzene. The matrix spiking solution should contain compounds that are expected to be found in the types of samples to be analyzed.

9.3 Procedure

9.3.1 Add all internal standards, surrogates, and matrix spiking compounds (when applicable) must be added to the samples before introduction into the GC/MS system.

9.3.2 Choose a sample introduction method

9.3.2.1 Purge-and-trap

9.3.2.1.1 This includes purge-and-trap for aqueous samples (Method 5030) and purge-and-trap for solid samples (Method 5035).

9.3.2.1.2 Method 5035 also provides techniques for extraction of high concentration solid and oily waste samples by methanol (and other water-miscible solvents) with subsequent purge-and-trap from an aqueous matrix using Method 5030.

9.3.2.1.3 Traditionally, the purge-and-trap of aqueous samples is performed at ambient temperature, while purging of soil/solid samples is performed at 40° C, to improve purging efficiency.

9.3.3 Each GC/MS system must be hardware-tuned to meet the criteria in the QC section of the SOP using a 5-50 ng injection or purging of 4-bromofluorobenzene (2-µL injection of the BFB standard).

Analyses must not begin until these criteria are met.

9.3.3.1 The mass spectrum of BFB will be acquired in the following manner.

9.3.3.1.1 Three scans (the peak apex scan and the scans immediately preceding and following the apex) are acquired and averaged.

9.3.3.1.2 Background subtraction is required, and must be accomplished using a single scan no more than 20 scans prior to the elution of BFB. Do not background subtract part of the BFB peak.

NOTE: All subsequent standards, samples, MS/MSDs, LCSs, and blanks associated with a BFB analysis must use identical mass spectrometer instrument conditions.

9.3.3 Set up the sample introduction system as outlined in the method of choice. A different calibration curve is necessary for each method because of the differences in conditions and equipment (5ml vs. 25ml or heated vs. un-heated purge).

9.3.5 Calibration

9.3.5.1 Calibration must be performed using 5 or more standards.

9.3.5.2 Calibration must be performed using the sample introduction technique that will be used for samples.

9.3.5.3 Transfer 5.0 mL (or 25 mL if lower detection limits are required) of each standard to a gas tight syringe along with internal standard. Then transfer the contents to the appropriate syringe.

9.3.5.4 Use the base peak ion from the specific internal standard as the primary ion for quantitation. If interferences are noted, use the secondary ion as the quantitation ion.

9.3.5.5 Tabulate the area response of the characteristic ions against the concentration for each target analyte and each internal standard.

9.3.5.6 Calculate response factors (RF) for each target analyte relative to one of the internal standards. The internal standard selected for the calculation of the RF for a target analyte should be the internal standard that has a retention time closest to the analyte being measured.

The RF is calculated as follows:

$$RF = \frac{A_s \times C_{is}}{A_{is} \times C_s}$$

where:

A s = Peak area (or height) of the analyte or surrogate.
A is= Peak area (or height) of the internal standard.
C s= Concentration of the analyte or surrogate.
C is= Concentration of the internal standard.

9.3.6 Initial Calibration Verification

9.3.6.1 Calculate the mean response factor (RF) and the relative standard deviation (RSD) of the response factors for each target analyte. The RSD should be less than or equal to 20% for each target analyte. It is also recommended that a minimum response factor for the most common target analytes as noted in Table 4, be demonstrated for each individual calibration level as a means to ensure that these compounds are behaving as expected. In addition, meeting the minimum response factor criteria for the lowest calibration standard is critical in establishing and demonstrating the desired sensitivity. Due to the large number of compounds that may be analyzed by this method, some compounds will fail to meet this criteria. For these occasions, it is acknowledged that the failing compounds may not be critical to the specific project and therefore they may be used as qualified data or estimated values for screening purposes. The analyst should also strive to place more emphasis on meeting the calibration criteria for those compounds that are critical project compounds, rather than meeting the criteria for those less important compounds.

9.3.6.2 If more than 10% of the compounds included with the initial calibration exceed the 20% RSD limit and do not meet the minimum correlation coefficient (0.99) for alternate curve fits, then the chromatographic system is considered too imprecise for analysis to begin. Adjust moisture control parameters, replace analytical trap or column, replace moisture trap or adjust desorb time, then repeat the calibration procedure beginning with Sec. 9.3.3.

9.3.7 Continuing Calibration Verification

9.3.7.1 The initial calibration will be evaluated every 12 hours.

9.3.7.2 All compounds will be evaluated against the appropriate initial calibration using the % difference calculation.

9.3.7.3 The % difference must be less than or equal to 20%.

9.3.8 Evaluation of retention times

9.3.8.1 The relative retention times (RRT) of each target analyte in each calibration standard should agree within 0.06 RRT units.

9.3.9 Linearity of target analytes

9.3.9.1 If the RSD of any target analyte is 20% or less, then the relative response factor is assumed to be constant over the calibration range, and the average relative response factor may be used for quantitation (Sec. 9.3.15).

9.3.9.2 If the RSD of any target analyte is greater than 20%, refer to SW846 Method 8000 for additional calibration options. One of the options must be applied to GC/MS calibration in this situation, or a new initial calibration must be performed. The average RF should not be used for compounds that have an RSD greater than 20% unless the concentration is reported as estimated.

9.3.9.3 When the RSD exceeds 20%, the plotting and visual inspection of a calibration curve can be a useful diagnostic tool. The inspection may indicate analytical problems, including errors in standard preparation, the presence of active sites in the chromatographic system, analytes that exhibit poor chromatographic behavior, etc.

9.3.9.4 Due to the large number of compounds that may be analyzed by this method, some compounds may fail to meet either the 20% RSD, minimum correlation coefficient criteria (0.99), or the acceptance criteria for alternative calibration procedures in SW846 Method 8000. Any calibration method stipulated in Method 8000 may be used, but it should be used consistently. It is considered inappropriate once the calibration analyses are completed to select an alternative calibration procedure in order to pass the recommended criteria on a case by case basis. If compounds fail to meet these criteria, the associated concentrations may still be determined but they must be reported as estimated. In order to report non-detects, it must be demonstrated that there is adequate sensitivity to detect the failed compounds at the applicable lower quantitation limit.

9.3.10 GC/MS calibration verification - Calibration verification is performed every 12 hours by the tuning with BFB, purging a continuing calibration verification standard, and analysis of a method blank.

9.3.10.1 The method of linear regression analysis has the potential for a significant bias to the lower portion of a calibration curve, while the relative percent difference and quadratic methods of calibration do not have this potential bias. When calculating the calibration curves using the linear regression model, a minimum quantitation check on the viability of the lowest calibration point should be performed by re-fitting the response from the low concentration calibration standard back into the curve (See SW846 Method 8000 for additional details). It is not necessary to re-analyze a low concentration standard, rather the data system can recalculate the concentrations as if it were an unknown sample. The recalculated concentration of the low calibration point should be within ± 30% of the standard's true concentration. Other recovery criteria may be applicable depending on the project's data quality objectives and for those situations the minimum quantitation check criteria should be outlined in a laboratory standard operating procedure, or a project-specific Quality Assurance Project Plan. Analytes which do not meet the minimum quantitation calibration refitting criteria should be considered "out of control" and corrective action such as redefining the lower limit of quantitation and/or reporting those "out of control" target analytes as estimated when the concentration is at or near the lowest calibration point may be appropriate.

9.3.10.2 Internal standard retention time - The retention times of the internal standards in the calibration verification standard must be evaluated immediately after or during data acquisition. If the retention time for any internal standard changes by more than 10 seconds from that in the mid-point standard level of the most recent initial calibration sequence, then the chromatographic system must be inspected for malfunctions and corrections must be made, as required. When corrections are made, reanalysis of samples analyzed while the system was malfunctioning is required.

9.3.10.3 Internal standard response - If the EICP area for any of the internal standards in the calibration verification standard changes by a factor of two (-50% to + 100%) from that in the mid-point standard level of the most recent initial calibration sequence, the mass spectrometer must be inspected for malfunctions and corrections must be made, as appropriate. When corrections are made, reanalysis of samples analyzed while the system was malfunctioning is required.

9.3.11 Sample Introduction

9.3.11.1 All samples and standard solutions must be allowed to warm to ambient temperature before analysis.

9.3.11.2 The process of taking an aliquot destroys the validity of remaining volume of an aqueous sample for future analysis.

9.3.11.3 Remove the plunger from a 5-mL syringe. Open the sample or standard bottle, which has been allowed to come to ambient temperature, and carefully pour the sample into the syringe barrel to just short of overflowing. Replace the syringe plunger and compress the sample adjusting the sample volume to 5.0 mL. If lower detection limits are required, use a 25 mL syringe, and adjust the final volume to 25.0 mL.

9.3.11.4 Add 5 µL of the surrogate spiking solution/internal standard spiking solution to each sample.

9.3.11.5 Addition of 5 µL of the surrogate spiking solution to 5 mL of aqueous sample will yield a concentration of 50 µg/L of each surrogate standard.

9.3.11.6 The addition of 5 µL of the surrogate spiking solution to 5 g of a non-aqueous sample will yield a concentration of 50 µg/kg of each standard.

9.3.11.7 Add 5 µL of the matrix spike solution to a 5-mL aliquot of the sample chosen for spiking. Disregarding any dilutions, this is equivalent to a concentration of 50 µg/L of each matrix spike standard.

9.3.11.8 Follow the same procedure in preparing the blank spike sample, except the spike is added to a clean matrix.

9.3.11.9 Analyze the sample following the procedure in the introduction method of choice.

9.3.11.10 If the initial analysis of the sample or a dilution of the sample has a concentration of any analyte that exceeds the initial calibration range, the sample must be reanalyzed at a higher dilution.

Secondary ion quantitation is allowed only when there are sample interferences with the primary ion.

9.3.11.11 When ions from a compound in the sample saturate the detector, this analysis must be followed by the analysis of an organic-free reagent water blank.

9.3.11.12 If the blank analysis is not free of interferences, then the system must be decontaminated.

9.3.11.13 Sample analysis may not resume until the blank analysis is demonstrated to be free of interferences.

9.3.11.14 All dilutions should keep the response of the major constituents (previously saturated peaks) in the upper half of the linear range of the curve.

9.3.12 Aqueous Sample Dilution

9.3.12.1 All steps must be performed without delays, until the diluted sample is in a gas-tight syringe.

9.3.12.2 Dilutions may be made in volumetric flasks (50 to 100-mL). Select the volumetric flask that will allow for the necessary dilution. Intermediate dilution steps may be necessary for extremely large dilutions. (Dilutions of 10x, 5x and 2x may be made using the luer-lok syringe.)

9.3.12.3 Calculate the approximate volume of organic-free reagent water to be added to the volumetric flask, and add slightly less than this quantity of organic-free reagent water to the flask.

9.3.12.4 Inject the appropriate volume of the original sample from the syringe into the flask. Aliquots of less than 1 mL are not recommended. Dilute the sample to the mark with organic-free reagent water. Cap the flask, invert, and shake three times. Repeat above procedure for additional dilutions.

9.3.12.5 Fill a 5-mL syringe with the diluted sample, and proceed as 9.3.11.3.

9.3.13 Qualitative analysis

9.3.13.1 The qualitative identification of each compound determined by this method is based on retention time, and on comparison of the sample mass spectrum, after background correction, with characteristic ions in a reference mass spectrum. The reference mass spectrum must be generated by the laboratory using the conditions of this method. The characteristic ions from the reference mass spectrum are defined to be the three ions of greatest relative intensity, or any ions over 30% relative intensity if less than three such ions occur in the reference spectrum. Compounds are identified as present when the following criteria are met.

9.3.13.1.1 The intensities of the characteristic ions of a compound maximize in the same scan or within one scan of each other. Selection of a peak by a data system target compound search routine where the search is based on the presence of a target chromatographic peak containing ions specific for the target compound at a compound-specific retention time will be accepted as meeting this criterion.

9.3.13.1.2 The relative retention time (RRT) of the sample component is within ± 0.06 RRT units of the RRT of the standard component.

9.3.13.1.3 The relative intensities of the characteristic ions agree within 30% of the relative intensities of these ions in the reference spectrum. (Example: For an ion with an abundance of 50% in the reference spectrum, the corresponding abundance in a sample spectrum can range between 20% and 80%.)

9.3.13.1.4 Structural isomers that produce very similar mass spectra should be identified as individual isomers if they have sufficiently different GC retention times. Sufficient GC resolution is achieved if the height of the valley between two isomer peaks is less than 50% of the sum of the two peak heights. Otherwise, structural isomers are identified as isomeric pairs.

9.3.13.1.5 Identification is hampered when sample components are not resolved chromatographically and produce mass spectra containing ions contributed by more than one analyte. When gas chromatographic peaks obviously represent more than one sample component (i.e., a broadened peak with shoulder(s) or a valley between two or more maxima), appropriate selection of analyte spectra and background spectra is important.

9.3.13.1.6 Examination of extracted ion current profiles (EICP) of appropriate ions can aid in the selection of spectra, and in qualitative identification of compounds. When analytes coelute (i.e., only one chromatographic peak is apparent), the identification criteria may be met, but each analyte spectrum will contain extraneous ions contributed by the coeluting compound.

9.3.13.2 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.

9.3.14 Tentatively Identified Compounds (TIC's): use the following guidelines to identify TIC's:

9.3.14.1 Relative intensities of major ions in the reference spectrum (ions greater than 10% of the most abundant ion) should be present in the sample spectrum.

9.3.14.2 The relative intensities of the major ions should agree within ± 20%. (Example: For an ion with an abundance of 50% in the standard spectrum, the corresponding sample ion abundance must be between 30 and 70%).

9.3.14.3 Molecular ions present in the reference spectrum should be present in the sample spectrum.

9.3.14.4 Ions present in the sample spectrum but not in the reference spectrum should be reviewed for possible background contamination or presence of coeluting compounds.

9.3.14.5 Ions present in the reference spectrum but not in the sample spectrum should be reviewed for possible subtraction from the sample spectrum because of background contamination or coeluting peaks. Data system library reduction programs can sometimes create these discrepancies.

9.3.15 Quantitative analysis

All calculations must be performed using the average RF or Linear Regression from the initial calibration.

9.3.15.1 Once a compound has been identified, the quantitation of that compound will be based on the integrated abundance from the EICP of the primary characteristic ion. The internal standard used shall be the one nearest the retention time of that of a given analyte.

9.3.15.1.1 It is highly recommended to use the integration produced by the software if the integration is correct because the software should produce more consistent integrations. However, manual integrations are necessary when the software does not produce proper integrations due to improper baseline selection, the correct peak is missed, a coelution is integrated, a peak is partially integrated, etc. The analyst is responsible for ensuring that the integration is correct whether performed by the software or done manually.

9.3.15.1.2 Manual integrations should not be substituted for proper maintenance of the instrument or setup of the method (e.g. retention time updates, integration parameter files, etc). The analyst should seek to minimize manual integration by properly maintaining the instrument, updating retention times, and configuring peak integration parameters. **Please refer to SOP-CIP-1, Chromatographic Integration Procedures for the complete manual integration policy.**

$$\text{Concentration ug/l} = \frac{(A_s)(C_{is})}{(A_{is})((RF)}$$

where:
A_s = Area of the characteristic m/z for the parameter or surrogate standard to be measured.
A_{is} = Area of the characteristic m/z for the internal standard.
C_{is} = Concentration of the internal standard.
RF = Response factor of analyte

Report results in μg/L without correction for recovery data.

9.3.15.2 Where applicable, the concentration of any TIC analytes identified in the sample should be estimated. The same formulae should be used with the following modifications: The areas A_s and A_{is} should be from the total ion chromatograms, and the RF for the compound should be assumed to be 1. The resulting concentration should be reported indicating that the value is an estimate. Use the nearest internal standard free of interferences.

9.4 Compositing of aqueous volatile grab samples

9.4.1 Individual acid preserved VOA vials are refrigerated until compositing occurs. A 500 ml round bottom flask that has been cleaned and baked at 180' C is cooled , then immersed in an ice bath. One vial from each grab sample is poured into the chilled flask. Once a vial from each grab is added to the iced flask, the contents are mixed with a glass stirring rod then poured into three 40 ml acid preserved VOA vials. These vials represent a composite of the individual grab samples and are ready for analysis, The holding time for analysis is calculated from the sample collection date.

10.0 Quality Control

10.1 Initial Demonstration of Proficiency - Each laboratory must demonstrate initial proficiency with each sample preparation and determinative method combination it utilizes, by generating data of acceptable accuracy and precision for target analytes in a clean matrix. The laboratory must also repeat the following operations whenever new staff is trained or significant changes in instrumentation are made.

10.2 Method Detection Limits (MDL)

10.2.1 MDL must be determined for all analytes using reagent water spiked at a concentration 2 to3 times the estimated detection limit. Analyze 7 replicate aliqouts of the fortified reagent water and process through the entire analytical procedure. Calculate the MDL as required in 40 CFR Appendix B.

10.3 On-going QC Requirements

10.3.1 Analytical QC requirements are detailed in the attached table. If any QC criteria is not met, the appropriate corrective action must be taken and the issue resolved prior to the continuation of the analysis.

SAMPLE TYPE	FREQUENCY	QC LIMIT	CORRECTIVE ACTION
Initial Demonstration of Capability (DOC) (Standard at 1-4 the RL)	Prepare 4 spike samples once at method start-up, whenever new staff is trained or significant changes in instrumentation are made	All analytes 70-130% recovery %RSD <=30%	Repeat procedure using fresh samples until satisfactory performance is demonstrated.
Method Detection Limit (MDL)	Prepare 7 spike samples at a low concentration once at method start-up and then 1 per year.	Calculate mean recovery and standard deviation. 3x std. Dev.= MDL	If MDL too high, repeat procedure.
Method Blank (MB)	One with every 20 samples or per sample set (all samples analyzed within a 12 hour period) whichever is greater.	All method parameters less than the MDL. < lowest limit of detection < 5% of the regulatory limit or < 5% sample result (See method 8000C)	If parameters greater than MDL in blank, re-analyze all samples that have positive identifications.
Blank Spike (LCS) (Spike concentration must be near mid point of curve)	One with every 20 samples or per sample set (all samples analyzed within a 12 hour period) whichever is greater.	Meet acceptance criteria for average recovery and standard deviation Found in Table 5	Source of problem must be identified and corrected before proceeding.

	All parameters must be spiked at least once during a 2 year period.		

SAMPLE TYPE	FREQUENCY	QC LIMIT	CORRECTIVE ACTION
Matrix Spike/Matrix Spike Duplicate (MS/MSD) (spike concentration must be the same as the blank spike)	One with every 20 samples or per sample set (all samples analyzed within a 12 hour period) whichever is greater.	Meet acceptance criteria for average recovery and standard deviation Found in Table 5	If the blank spike is in control, and the MS/MSD is out of control, matrix interference is suspected.
Initial Calibration @ 1, 10, 20, 50, 100 ug/l	Initially and then as required by instrument performance.	%RSD <20% Correlation Coefficient ≥ 0.99	If %RSD >20% reanalyze curve and adjust instrument if necessary.
Initial Calibration @ 1, 2, 5, 10, 20, 50 ug/l	Initially and then as required by instrument performance.	%RSD <20% Correlation Coefficient ≥ 0.99	If %RSD >20% reanalyze curve and adjust instrument if necessary.
Initial Calibration Verification (ICV) Separate source from Calibration Std.	After initial calibration	±30%	Recalibrate and reanalyze associated analytes that fail the criteria.
Continuing Calibration at **50ug/l** (calibration standard at mid point of curve)	Once every 12 hours to verify the initial calibration.	%Difference ≤20% Meet minimum R.F. from Table 4	Recalibrate
Continuing Calibration at **20ug/l** (calibration standard at mid point of curve)	Once every 12 hours to verify the initial calibration.	%Difference ≤20% Meet minimum R.F. from Table 4	Recalibrate
When using Linear Regression		Re-calculate low calibration point as	See sec. 9.3.10.1

		unknown recovery ± 30%	
SAMPLE TYPE	**FREQUENCY**	**QC LIMIT**	**CORRECTIVE ACTION**
Sample Internal Standards Fluorobenzene, chlorobenzene-d5	Added to every sample, standard and QC sample	Area counts of the IS peak will be between 50-200% of the areas of the target analytes in the mid-point calibration analysis. RT ± 10 secs. from that in mid-point standard	If area counts or RT outside limits, re-analyze sample. If fails again submit both analyses using the RE suffix for the second analysis.
Sample Internal Standards Bromochloromethane 1,4-difluorobenzene chlorobenzene-d5			
BFB Tuning	Once every 12 hours`	m/z — Required Intensity (relative abundance) 50 — 15 to 40% of m/z 95 75 — 30 to 60%of m/z 95 95 — Base peak, 100% relative abundance 96 — 5 to 9% of m/z 95 173 — Less than 2% of m/z 174 174 — Greater than 50% of m/z 95 175 — 5 to 9% of m/z 174 176 — Greater than 95% but less than 101% of m/z 174 177 — 5 to 9% of m/z 176	If criteria fails, halt analysis and adjust instrument. Re-tune. Do not submit any data without meeting tune criteria. Alternate tuning criteria may be used, (e.g. CLP, Method 524.2, or manufacturers instructions) provided that method performance is not adversely affected.

CHROMATOGRAPHIC CONDITIONS

Gas Chromatograph	Condition
Injector Temperature	150 C
Transfer line temperature	120 C
DB-624 Column	Method specific. Carrier Gas 42-46ml/min Initial Temp 35 C, hold for 6 minutes Temp Program 6 C/min to 200 C Final Temperature 200 C for 5 min Depends on desired parameter list.
Mass range	45-260 for 2 min then 35-260 for remainder of run
Scan time	1.6 scan/sec
Source temperature	According to manufacturers specifications
Ion trap only	Set axial modulation, manifold temperature, and emission current to manufacturers recommendations.

11.0 Definitions

Acceptance Criteria: Specified limits placed on characteristics of an item, process, or service defined in requirement documents.

Accuracy: The closeness of agreement between an observed value and an accepted reference value. When applied to a set of observed values, accuracy will be a combination of a random component and of a common systematic error (or bias) component.

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.

Batch: Environmental samples that 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 (1) to twenty (20) environmental samples of the same quality systems 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 twenty-four (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 twenty (20) samples.

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.

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.

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.

Calibration Standard: A substance or reference material used for calibration.

Certified Reference Material (CRM): Reference material accompanied by a certificate, having a value, measurement uncertainty, and stated metrological traceability chain to a national metrology institute.

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.

Control Sample: A QC sample introduced into a process to monitor the performance of the system.

Demonstration of Capability (DOC): A procedure to establish the ability of the analyst to generate analytical results of acceptable accuracy and precision.

Duplicate: see Matrix Duplicate (MD), Field Duplicate, Matrix Spike Duplicate (MSD).

Field Duplicates: Independent samples which are collected as close as possible to the same point in space and time. They are two separate samples taken from the same source, stored in separate containers, and analyzed independently. These duplicates are useful in documenting the precision of the sampling process.

Holding Times: The maximum time that can elapse between two specified activities.

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 method.

Laboratory Control Sample (LCS): A known matrix spiked with compound(s) representative of the target analytes. This is used to document laboratory performance.

Matrix: The component or substrate (e.g., surface water, drinking water), which contains the analyte of interest.

Matrix Duplicate (MD): An intralaboratory split sample which is used to document the precision of a method in a given sample matrix.

Matrix Spike (MS): An aliquot of sample spiked with a known concentration of target analyte(s). The spiking occurs prior to sample preparation and analysis. A matrix spike is used to document the bias of a method in a given sample matrix.

Matrix Spike Duplicate (MSD): Intralaboratory split samples spiked with identical concentrations of target analyte(s). The spiking occurs prior to sample preparation and analysis. They are used to document the precision and bias of a method in a given sample matrix.

Method Blank (MB): An analyte-free matrix to which all reagents are added in the same volumes or proportions as used in sample processing. The method blank should be carried through the complete sample preparation and analytical procedure. The method blank is used to document contamination resulting from the analytical process. For a method blank to be acceptable for use with the accompanying samples, the concentration in the blank of any analyte of concern should not be higher than the highest of either:
(1) The method detection limit, or
(2) Five percent of the regulatory limit for that analyte,

or
(3) Five percent of the measured concentration in the sample.
Method Detection Limit (MDL): The minimum concentration of a substance 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 type containing the analyte.
National Institute of Standards and Technology (NIST): A federal agency of the US Department of Commerce's Technology Administration that is designed as the United States national metrology institute (NMI).
Organic-Free Reagent Water: All references to water in the method refer to water in which an interferant is not observed at the method detection limit of the compounds of interest. Organic-free reagent water can be generated by passing tap water through a carbon filter bed containing about 1 pound of activated carbon. A water purification system may be used to generate organic-free deionized water.
Preservation: Any conditions under which a sample must be kept in order to maintain chemical and/or biological integrity prior to analysis.
Project: Single or multiple data collection activities that are related through the same planning sequence.
Quality Assurance Project Plan (QAPP): **An orderly assemblage of detailed procedures designed to produce data of sufficient quality to meet the data (QAPP): quality objectives for a specific data collection activity.**
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 and quality needed and expected by the client.
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.
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.**
Reagent Blank: See Method Blank.
Reagent Grade: Analytical reagent (AR) grade, ACS reagent grade, and reagent grade are synonymous terms for reagents which conform to the current specifications of the Committee on Analytical Reagents of the American Chemical Society.
Reagent Water: Water that has been generated by any method which would achieve the performance specifications for ASTM Type II water.
Reference Material: A material containing known quantities of target analytes in solution or in a homogeneous matrix. It is used to document the bias of the analytical process.
Reference Standard: Standard used for the calibration of working measurement standards in a given organization or at a given location.
Reporting limit or RL is the LOQ or Limit of Quantitation:, the constituent concentration that produces a signal sufficiently greater than the blank that it can be detected within specified levels by good laboratories during routine operating conditions.
Sampling: Activity related to obtaining a representative sample of the object of conformity assessment, according to a procedure.

Split Samples: Aliquots of sample taken from the same container and analyzed independently. In cases where aliquots of samples are impossible to obtain, field duplicate samples should be taken for the matrix duplicate analysis. These are usually taken after mixing or compositing and are used to document intra- or interlaboratory precision.

Surrogate: An organic compound which is similar to the target analyte(s) in chemical composition and behavior in the analytical process, but which is not normally found in environmental samples.

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.

Trip Blank: A sample of analyte-free media taken from the laboratory to the sampling site and returned to the laboratory unopened. A trip blank is used to document contamination attributable to shipping and field handling procedures. This type of blank is useful in documenting contamination of volatile organics samples.

TABLE 4
RECOMMENDED MINIMUM RELATIVE RESPONSE FACTOR CRITERIA FOR INITIAL AND CONTINUING CALIBRATION VERIFICATION

Volatile Compounds	Minimum Response Factor (RF)a	Typical Response Factor (RF)b
Dichlorodifluoromethane	0.100	0.327
Chloromethane	0.100	0.537
Vinyl chloride	0.100	0.451
Bromomethane	0.100	0.255
Chloroethane	0.100	0.254
Trichlorofluoromethane	0.100	0.426
1,1-Dichloroethene	0.100	0.313
1,1,2-Trichloro-1,2,2-trifluoroethane	0.100	0.302
Acetone	0.100	0.151
Carbon disulfide	0.100	1.163
Methyl Acetate	0.100	0.302
Methylene chloride	0.100	0.380
trans-1,2-Dichloroethene	0.100	0.351
cis-1,2-Dichloroethene	0.100	0.376
Methyl tert-Butyl Ether	0.100	0.847
1,1-Dichloroethane	0.200	0.655
2-Butanone	0.100	0.216
Chloroform	0.200	0.557
1,1,1-Trichloroethane	0.100	0.442
Cyclohexane	0.100	0.579
Carbon tetrachloride	0.100	0.353
Benzene	0.500	1.368
1,2-Dichloroethane	0.100	0.443
Trichloroethene	0.200	0.338
Methylcyclohexane	0.100	0.501
1,2-Dichloropropane	0.100	0.382
Bromodichloromethane	0.200	0.424
cis-1,3-Dichloropropene	0.200	0.537
trans-1,3-Dichloropropene	0.100	0.515
4-Methyl-2-pentanone	0.100	0.363
Toluene	0.400	1.577
1,1,2-Trichloroethane	0.100	0.518
Tetrachloroethene	0.200	0.606
2-Hexanone	0.100	0.536
Dibromochloromethane	0.100	0.652
1,2-Dibromoethane	0.100	0.634
Chlorobenzene	0.500	1.733
Ethylbenzene	0.100	2.827

meta-/para-Xylene	0.100	1.080
ortho-Xylene	0.300	1.073
Styrene	0.300	1.916

TABLE 4 (cont.)

RECOMMENDED MINIMUM RELATIVE RESPONSE FACTOR CRITERIA FOR INITIAL AND CONTINUING CALIBRATION VERIFICATION

Volatile Compounds	Minimum Response Factor (RF)[a]	Typical Response Factor (RF)[b]
Bromoform	0.100	0.413
Isopropylbenzene	0.100	2.271
1,1,2,2-Tetrachloroethane	0.300	0.782
1,3-Dichlorobenzene	0.600	1.408
1,4-Dichlorobenzene	0.500	1.427
1,2-Dichlorobenzene	0.400	1.332
1,2-Dibromo-3-chloropropane	0.050	0.129
1,2,4-Trichlorobenzene	0.200	0.806

[a] The project-specific response factors obtained may be affected by the quantitation ion selected and when using possible alternate ions the actual response factors may be lower than those listed. In addition, lower than the recommended minimum response factors may be acceptable for those compounds that are not considered critical target analytes and the associated data may be used for screening purposes.

[b] Data provided by EPA Region III laboratory.

Table 5—Calibration and QC Acceptance Criteria

Parameter	Range for Q (μ/g/L)	Limit for s (μ/g/L)	Range for X (μ/g/L)	Range for P, P_s (%)
Benzene	12.8 - 27.2	6.9	15.2 - 26.0	37 – 151
Bromodichloromethane	13.1 - 26.9	6.4	10.1 - 28.0	35 – 155
Bromoform	14.2 - 25.8	5.4	11.4 - 31.1	45 – 169
Bromomethane	2.8 - 37.2	17.9	D - 41.2	D – 242
Carbon tetrachloride	14.6 - 25.4	5.2	17.2 - 23.5	70 – 140
Chlorobenzene	13.2 - 26.8	6.3	16.4 - 27.4	37 – 160
Chloroethane	7.6 - 32.4	11.4	8.4 - 40.4	14 – 230
2-Chloroethylvinyl ether	D - 44.8	25.9	D - 50.4	D – 305
Chloroform	13.5 - 26.5	6.1	13.7 - 24.2	51 – 138
Chloromethane	D - 40.8	19.8	D - 45.9	D – 273
Dibromochloromethane	13.5 - 26.5	6.1	13.8 - 26.6	53 – 149
1,2-Dichlorobenzene	12.6 - 27.4	7.1	11.8 - 34.7	18 – 190
1,3-Dichlorobenzene	14.6 - 25.4	5.5	17.0 - 28.8	59 – 156
1,4-Dichlorobenzene	12.6 - 27.4	7.1	11.8 - 34.7	18 – 190
1,1-Dichloroethane	14.5 - 25.5	5.1	14.2 - 28.5	59 – 155
1,2-Dichloroethane	13.6 - 26.4	6.0	14.3 - 27.4	49 – 155
1,1-Dichlorothene	10.1 - 29.9	9.1	3.7 - 42.3	D – 234
trans-1,2-Dichloroethene	13.9 - 26.1	5.7	13.6 - 28.5	54 – 156
1,2-Dichloropropane	6.8 - 33.2	13.8	3.8 - 36.2	D – 210
cis-1,3-Dichloropropene	4.8 - 35.2	15.8	1.0 - 39.0	D – 227
trans-1,3-Dichloropropene	10.0 - 30.0	10.4	7.6 - 32.4	17 – 183
Ethyl benzene	11.8 - 28.2	7.5	17.4 - 26.7	37 – 162
Methylene chloride	12.1 - 27.9	7.4	D - 41.0	D – 221
1,1,2,2-Tetrachloroethane	12.1 - 27.9	7.4	13.5 - 27.2	46 – 157
Tetrachloroethene	14.7 - 25.3	5.0	17.0 - 26.6	64 – 148
Toluene	14.9 - 25.1	4.8	16.6 - 26.7	47 – 150
1,1,1-Trichloroethane	15.0 - 25.0	4.6	13.7 - 30.1	52 – 162
1,1,2-Trichloroethane	14.2 - 25.8	5.5	14.3 - 27.1	52 – 150
Trichloroethene	13.3 - 26.7	6.6	18.6 - 27.6	71 – 157
Trichlorofluoromethane	9.6 - 30.4	10.0	8.9 - 31.5	17 – 181
Vinyl chloride	0.8 - 39.2	20.0	D - 43.5	D - 251

Q = Concentration measured in QC check sample, in μg/L.
s = Standard deviation of four recovery measurements, in μg/L.
X= Average recovery of four recovery measurements, in μg/L.
P, P_s = Percent recovery measured.
D = Detected; result must be greater than zero.
[a]Criteria were calculated assuming a QC check sample concentration of 20 μg/L.

STANDARD OPERATING PROCEDURE

1.0 PROCEDURE TITLE: Determination of Metals and Trace Elements by Inductively Coupled Plasma-Atomic Emission Spectrometry, EPA Methods 200.7 and 6010C

Approvals and Signatures

Laboratory Director: Renée Cusack Date: 1/30/13

QA Manager: Maria O Date: 1/30/13

Section Supervisor: Maria O Date: 1/30/13

EH&S Officer: Ken Powell Date: 1/30/13

Control #: 146

2.0 AREA OF APPLICABILITY: Inorganic Chemistry

3.0 SCOPE AND APPLICATION: Inductively coupled plasma- atomic emission spectrometry (ICP-AES) is used to determine metals and some nonmetals in solution. This method is applicable to the following analytes listed in methods 200.7 and 6010C: Al, Sb, As, Ba, Be, B, Cd, Ca, Ce*, Cr, Co, Cu, Fe, Pb, Li, Mg, Mn, Mo, Ni, P*, K, Se, SiO2, Ag, Na, Sr, Tl, Sn, Ti, V, Zn as well as: Au*, Pd*, Pt*, S, W, Ga, Ge, Re, Ru, Ta, and Hf. (* 200.7 only) Additional elements may be included in this procedure provided that the performance criteria presented in section 10 (Quality Control) are met. However, project approval may be required from either a controlling agency or client for compliance testing beyond the elements stated in the promulgated methods.

3.1 ICP-AES can be used to determine dissolved analytes in aqueous samples after suitable filtration and acid preservation. To reduce potential interferences, dissolved solids should be <0.2% (w/v) (Section 7.2).

3.2 With the exception of silver, where this method is approved for the determination of certain metal and metalloid contaminants in drinking water, samples may be analyzed directly by pneumatic nebulization without acid digestion if the sample has been properly preserved with acid and has turbidity <1 NTU at the time of analysis. This total recoverable determination is referred to as "direct analysis".

3.3 For the determination of total recoverable analytes in aqueous and solid samples a digestion/extraction is required prior to analysis when the elements are not in solution (e.g. soils, sludge, TCLP extracts, sediments and aqueous samples that may contain particulate and suspended solids).

Aqueous samples containing suspended or particulate material $\geq$ 1% (w/v) should be extracted as a solid type sample.

4.0 PRINCIPLE: This SOP describes multielemental determinations by ICP-AES using simultaneous optical systems and axial viewing of the plasma. The instrument measures characteristic emission spectra by optical spectrometry. The sample is nebulized and the aerosol that is produced is transported to the plasma torch where desolvation and excitation occur. Characteristic atomic-line emission spectra are produced by a radio-frequency inductively coupled plasma (ICP). The spectra are dispersed by a grading spectrometer, and line intensities are monitored by a photosensitive device are processed and controlled by a computer system.

5.0 REFERENCES

5.1 "Methods for Chemical Analysis of Water and Wastes", EPA Method 200.7, Revision 4.4 (1994).

5.2 "Test Methods for Evaluating Solid Waste Physical/Chemical Methods", Method 6010C, Inductively Coupled Plasma-Atomic Emission Spectrometry, Revision 3, February 2007.

6.0 PRESERVATION AND HOLD TIME

6.1 All sample containers must be demonstrated to be free of contamination at or below the reporting limit. Plastic and glass containers are both suitable.

6.2 Prior to the collection of an aqueous sample, consideration should be given to the type of data required, (i.e., dissolved or total recoverable), so that appropriate preservation and pretreatment steps can be taken. The pH of all aqueous samples **must** be tested immediately prior to aliquoting for processing or "direct analysis" to ensure the sample has been properly preserved. If properly acid preserved, the sample can be held up to six months before analysis.

6.3 Samples preserved with concentrated HNO3 to a pH <2 (usually 1.5mL conc. HNO3/L sample, more may be required for some alkaline or highly buffered samples). Filter samples for dissolved metals through a 0.45 um pore diameter membrane filter before preserving.

6.4 Preservation may be done at the time of collection; however, to avoid the hazards of strong acids in the field, transport restrictions, and possible contamination it is recommended that the samples be returned to the laboratory within two weeks of collection and acid preserved upon receipt in the laboratory. Following acidification, the sample should be mixed, held for 16 hours for drinking waters, 24 hours for other aqueous samples, and then verified to be pH <2 just prior to withdrawing an aliquot for processing or "direct analysis". If for some reason such as high alkalinity the sample pH is verified to be >2, more acid must be added and the sample held for 16 hrs. for drinking waters, 24 hrs. for other aqueous samples until verified to be pH <2.

Note: When the nature of the sample is either unknown or is known to be hazardous, acidification should be done in a fume hood.

6.5 Holding time is 6 months from sampling for preserved samples.

7.0 INTERFERENCES

7.1 Spectral Interferences are caused by background emission from continuous or recombination phenomena, stray light from the line emission of high concentration elements, overlap of a spectral line from another element, or unresolved overlap of molecular band spectra.

7.2 Spectral overlaps may be avoided by using an alternate wavelength or can be compensated for by equations that correct for interelement contributions, which involves measuring the interfering elements.

7.3 When interelement corrections are applied, there is a need to verify their accuracy by analyzing spectral interference check solutions. Interelement corrections will vary for the same emission line among instruments because of differences in resolution, as determined by the grating plus the entrance and exit slit widths, and by the order of dispersion. Interelement corrections will also vary depending upon the choice of background correction points. Selecting a background correction point where an interfering emission line may appear should be avoided when practical. Interelement corrections that constitute a major portion of an emission signal may not yield accurate data. Users should not forget that some samples may contain uncommon elements that could contribute spectral interferences.

7.4 Physical Interferences are effects associated with sample nebulization and transport processes. Changes in viscosity and surface tension can cause significant inaccuracies, especially in samples containing high dissolved solids or high acid concentrations. If physical interferences are present, they must be reduced by such means as a high-solids nebulizer, diluting the sample, using a peristaltic pump, or using an appropriate internal standard element. Another problem that can occur with high dissolved solids is salt buildup at the tip of the nebulizer, which affects aerosol flow rate and causes instrument drift. This problem can be controlled by a high solids nebulizer, wetting the argon prior to nebulization, using a tip washer, or diluting the sample. Also, it has been reported that better control of the argon flow rates, especially for the nebulizer, improves instrument stability and precision; this is accomplished with the use of mass flow controllers.

7.5 Chemical interferences include molecular-compound formation, ionization effects, and solute-vaporization effects. Normally, these effects are not significant with the ICP-OES technique. If observed, they can be minimized be careful selection of operating conditions (such as incident power and observation height), by buffering of the sample, by matrix matching, and by standard-addition procedures. Chemical interferences are highly dependent on matrix type and the specific analyte element.

7.6 Memory interferences result when analytes in a previous sample contribute to the signals measured in a new sample. Memory effects can result from sample deposition on the uptake tubing to the nebulizer and from the buildup of sample material in the plasma torch and spray chamber. The site where these effects occur is dependent on the element and can be minimized by flushing the system with a rinse blank between samples. The possibility of memory interferences should be recognized within an analytical run and suitable rinse times should be used to reduce them.

7.7 The method of standard additions (MSA) can be useful when certain interferences are encountered.

8.0 APPLICABLE/ASSOCIATED SOPS

8.1 SAFETY

8.1.1 Employees must abide by the policies and procedures in the Corporate Safety Manual, Radiation Safety Manual and this document.

8.1.2 SPECIFIC SAFETY CONCERNS OR REQUIREMENTS

8.1.2.1 The ICP plasma emits strong UV light and is harmful to vision. All analysts must avoid looking directly at the plasma.

8.1.3 PRIMARY MATERIALS USED

8.1.3.1 The following is a list of the materials used in this method, which have a serious or significant hazard rating. NOTE: This list does not include all materials used in the method. The table contains a summary of the primary hazards listed in the MSDS for each of the materials listed in the table. A complete list of materials used in the method can be found in the reagents and materials section. Employees must review the information in the MSDS for each material before using it for the first time or when there are major changes to the MSDS

Material (1)	Hazards	Exposure Limit (2)	Signs and symptoms of exposure
Nitric Acid	Corrosive Oxidizer Poison	2 ppm-TWA 4 ppm-STEL	Nitric acid is extremely hazardous; it is corrosive, reactive, an oxidizer, and a poison. Inhalation of vapors can cause breathing difficulties and lead to pneumonia and pulmonary edema, which may be fatal. Other symptoms may include coughing, choking, and irritation of the nose, throat, and respiratory tract. Can cause redness, pain, and severe skin burns. Concentrated solutions cause deep ulcers and stain skin a yellow or yellow-brown color. Vapors are irritating and may cause damage to the eyes. Contact may cause severe burns and permanent eye damage.
1 – Always add acid to water to prevent violent reactions.			
2 – Exposure limit refers to the OSHA regulatory exposure limit.			

8.2 WASTE MANAGEMENT AND POLLUTION PREVENTION

8.2.1 All waste will be disposed of in accordance with Federal, State and Local regulations. Where reasonably feasible, technological changes have been implemented to minimize the potential for pollution of the environment. Employees will abide by this method and the policies in section 13 of the Corporate Safety Manual for "Waste Management and Pollution Prevention."

8.2.2 Waste Streams Produced by the Method

8.2.2.1 The following waste streams are produced when this method is carried out.

8.2.2.1.1 Acid waste consisting of sample and rinse solution must be discarded down the acid neutralizing sink in the wet chem. area.

9.0 PROCEDURE

9.1 Reagents

9.1.1 Only high purity reagents will be used. All acids will be of high purity grade.

9.1.1.1 Nitric Acid (HNO3) concentrated (specific gravity 1.41)

9.1.2 Reagent water (De-Ionized water - DI water), reagent water must be free of interferences.

9.1.2.1 Required for all sample preparation and dilutions. Dilutions are to be made using acidified reagent water.

9.1.3 Standard Stock Solutions

9.1.3.1 These standards may be purchased from a reputable commercial source or prepared from ultra high purity grade chemicals or metals.

9.1.4 Calibration (CAL) Standards

9.1.4.1 Prepare mixed CAL standards by combining volumes of the stock solutions plus 5ml of nitric acid in 100ml volumetric flasks. See ICP standards prep book for a detailed description of these solutions.

Note: Care should be taken when preparing the mixed standards to ensure that the elements are compatible and stable together.

9.2 Preparation of Required QC Samples

9.2.1 Calibration Blank

9.2.1.1 Used in establishing the analytical curve.

9.2.1.2 Prepare by adding 5ml nitric acid to 50 ml DI water and dilute to 100ml.

9.2.2 Method (or Preparation) Blank (MB)

9.2.2.1 Contains all the reagents in the same volumes used in processing the samples. The MB is carried though entire preparation procedure and analysis scheme.

9.2.3 Reagent blank

9.2.3.1 Prepare this acid wash solution in the same manner as the calibration blank.

9.2.4 Initial Calibration Verification Standard (ICV)

9.2.4.1 A solution independent from the solutions used for calibration to verify the calibration of the instrument. Ag should be kept to a concentration of < 500ug/L.

9.2.4.1.1 See ICP std. prep book for a detailed description of this solution.

9.2.4.1.2 Store in a Teflon bottle.

9.2.5 Continuing Calibration Verification Standard (CCV)

9.2.5.1 Prepare in the same acid matrix using a source that is the same as or independent from the standards used for calibration at a concentration near the midpoint of the calibration curve. Must be at a different concentration than the ICV standard. Ag should be kept to a concentration of <500ug/L.

9.2.5.1.1 See ICP std. prep book for a detailed description of this solution.

9.2.5.1.2 Store in a Teflon bottle.

9.2.6 CRI Standard

9.2.6.1 Prepare in the same acid matrix as standards. The concentration must be equal to the reporting limit for all elements.

9.2.6.1.1 See ICP std. prep book for a detailed description of this solution.

9.2.6.1.2 Store in a Teflon bottle.

9.2.7 Interference Check Standards (ICS)

9.2.7.1 Comparing spectral interference of one element on another.

9.2.7.1.1 ICSA

9.2.7.1.1.1 In a volumetric flask with 50ml DI water, add 5ml nitric.

9.2.7.1.1.2 Add 10.0ml (or 2.0ml) Interferent A and dilute to 100ml. Standard volume may be adjusted according to the instrument's linear range.

Stock Solution Analyte	Analyte Conc. mg/l (using 10.0mL of std. A)	(2.0mL of std)
Al	500	100
Ca	500	100
Fe	200	40
Mg	500	100

9.2.7.1.1.3 Store in a Teflon bottle.

9.2.7.1.2 ICSAB

9.2.7.1.2.1 In a 100 ml volumetric flask with 50ml DI water add 5ml nitric acid.

9.2.7.1.2.2 Add 1.0ml of Interferent B

9.2.7.1.2.3 Add 10.0ml (or 2.0ml) of Interferent A and dilute to 100ml. (Adjust volume of standard as in 9.2.7.1.1.2)

	Stock Solution Analyte	Analyte Conc. mg/l (using 10.0mL of std. A)	(2.0mL of std)
Int A:	Al	500	100
	Ca	500	100
	Fe	200	40
	Mg	500	100
Int B	Cd	1.0	
	Ni	1.0	
	Zn	1.0	
	Ba	0.50	
	Be	0.50	
	Co	0.50	
	Cr	0.50	
	Cu	0.50	
	Mn	0.50	
	V	0.50	

Sb	0.60
As	0.10
Pb	0.05
Se	0.05
Ag	0.20
Tl	0.10

9.2.7.1.2.4 Store in a Teflon bottle.

9.3 Apparatus

- 9.3.1 Inductively Coupled Plasma Atomic Emission Spectrometer.
- 9.3.2 Argon gas supply – liquid high purity grade (99.99%)
- 9.3.3 Nitrogen
  - 9.3.3.1 Used as shear gas to shear off tip of plasma.
- 9.3.4 Radiofrequency generator.
- 9.3.5 Computer controlled atomic emission spectrometer with background correction.
- 9.3.6 Volumetric Flask
- 9.3.7 Volumetric Pipets

9.4 Analysis

- 9.4.1 Operating conditions
  - 9.4.1.1 The analyst should follow the instructions provided by the manufacture to verify the instrument configuration and operating conditions needed to satisfy the analytical requirements and to maintain quality control of analytical results.
  - 9.4.1.2 Preliminary treatment of most matrices is necessary because of the complexity and variability of sample matrices. Groundwater and other aqueous samples designated for a dissolved metal determination which have been prefiltered and acidified will not need acid digestion. However, all associated QC samples (i.e., method blank, LCS and MS/MSD) must undergo the same filtration and acidification procedures.
  - 9.4.1.3 Instrument Status Analysis
    - 9.4.1.3.1 The computer performs a check of the instrument to determine whether the electronics, systems and communications are working properly.
    - 9.4.1.3.2 To be done on a daily basis.
- 9.4.2 Select appropriate program
- 9.4.3 Begin calibration
- 9.4.4 Fit curves according to instrument instructions.
- 9.4.5 Analyze ICV, ICB (reagent blank)

9.4.6 Analyze CRI (as many standards as needed to meet RL requirements) (count as a sample)

9.4.7 Analyze ICSA then ICSAB (count as samples)

9.4.8 Analyze CCV, CCB (reagent blank) and then after every 10 samples thereafter

9.4.9 Analyze method blank (MB) if needed

9.4.10 Analyze Known (LCS) if needed

9.4.11 Analyze samples with duplicate (DU) and spike (MS)

9.4.12 Analyze a serial dilution (SD): This is performed to ensure that neither a positive or negative interference is operating on any of the analyte elements to distort the accuracy of the reported values.

9.4.12.1 Analyze 1 SD per analytical sequence/matrix.

9.4.12.2 Perform a 1:5 dilution on a sample and analyze.

9.4.12.3 If the analyte concentration is sufficiently high (50x the MDL), the dilution should agree within 10% of the original result. If not a chemical or physical interference effect should be suspected.

9.4.13 Post Digestion Spike (PDS): If required by client a PDS is analyzed when the pre-digestion spike recovery for an element falls outside the control limit and sample concentration does not exceed 4x the concentration of the spike added. (Exception Ag)

9.4.13.1 Spike an unspiked aliquot of sample or its dilution at a concentration of 2x the indigenous level or 2x the CRDL, whichever is greater.

9.4.13.2 The recovery should be within limits. If not, a matrix effect should be suspected.

9.4.14 After all samples have been analyzed, end the run by analyzing a CRI, ICSA, ICSAB, CCV and CCB. **Note: CRI, ICSA and ICSAB count as samples.**

9.4.15 Determined sample analyte concentrations that are greater than 90% of the determined upper Linear dynamic range (LDR) limit must be diluted and reanalyzed.

9.4.16 For the analysis of wastewater samples containing concentrations of silver >100ug/l, succeeding smaller volume, well mixed aliquots should be prepared until the analysis solution contains <100 ug/L silver. The extraction of solid samples containing concentrations of silver >50 mg/kg should be treated in a similar manner.

9.5 Calculation

9.5.1 All samples are reported off the instrument and are reported units of ug/L.

10.0 QUALITY CONTROL

QC ANALYSIS	FREQUENCY	QC CRITERIA	CORRECTIVE ACTION
Initial Demonstration of Capability (IDOC)	At least 4 aliquots of standard 1-4 Xs reporting limit shall be prepared and analyzed as per method either concurrently or over a period of days. This must be done for all new personnel and at any time there is a change in instrumentation or method.	Mean recovery 85-115% Standard Deviation ≤ 10.0%	Repeat procedure using fresh samples until satisfactory performance is demonstrated. (May need to optimize instrument settings. See manufactures instructions.)
Interelement correction factors (IEC)	At start up according to manufacturer's directions and then checked annually or if there is a change in operating conditions.	See method 200.7 rev. 4.4 section 4.1	If annual check fails re-run check, if still fails re-analyze IEC factors.
Linear dynamic range (LDR)	At start up then verified annually or whenever, in the judgment of the analyst, a change in operating conditions would dictate.	Within 10% of standard value	Samples above 90% of the LDR must be diluted and reanalyzed.
Method Detection Limit Study (MDL)	Prepare 7 spike samples at a concentration 1 to 4 times the suspected MDL at method start-up and then annually.	Calculate mean recovery and standard deviation.	See MDL SOP
Initial Calibration	Once every 24 hours or each time the instrument is set up	R≥ 0.995	Re-analyze standards; if still problematic, check stock standards and reagents
Initial Calibration Verification (ICV)	Analyze immediately following calibration. One per analytical sequence	Limits: 95-105% (200.7) 90-110% (6010B)	Re-analyze one time, if still falls outside the control limit the analysis must be terminated, the cause determined and the instrument must be re-calibrated.
Initial Calibration Blank (ICB)	Analyze immediately after ICV. One per analytical sequence.	< CRDL	Re-analyze one time, if the ICB still contains concentrations > CRDL, the analysis must be terminated, the cause determined and the instrument must be re-calibrated.

QC ANALYSIS	FREQUENCY	QC CRITERIA	CORRECTIVE ACTION
CRI Standard	Analyzed at the beginning and end of each analytical sequence	No limits (200.7). 70-130% (6010B).	Reanalyze samples<2Xs CRI
Continuing Calibration Verification (CCV)	Every 10 samples	90-110%	If the percent recovery falls outside the acceptable limits. Re-analyze one time, if still falls outside the control limit the analysis must be terminated, the cause determined and the instrument must be re-calibrated. The samples bracketed by that CCV must be re-analyzed.
Continuing Calibration Blank (CCB)	Every 10 samples	< CRDL	Re-analyze one time, if the CCB still fails, the analysis must be terminated, the cause determined and the instrument must be re-calibrated. The samples bracketed by that CCB must be re-analyzed.
ICSA (initial and final)	Analyzed at the beginning and end of each analytical sequence	Al, Ca, Fe and Mg 80 – 120% All other elements absolute value ≤CRDL, if CDRL is ≤ 10ug/l absolute value should be ≤ 2Xs CRDL	If the recovery falls outside the acceptable limits, the analysis must be terminated, the caused determined and the instrument re-calibrated.
ICSAB (initial and final)	Analyzed at the beginning and end of each analytical sequence	80 – 120%	If the recovery falls outside the acceptable limits, elements that fail may not be reported. The analysis must be terminated, the caused determined and the instrument re-calibrated for those elements
Method Blank (MB)	One per Digestion Batch of 20 samples or less.	< CRDL **(1) See note at end of table**	If MB contains concentrations >CRDL, sample concentrations 10Xs > the MB may be reported with a NCM. Sample concentrations <CRDL may also be reported with a NCM. All other samples must be re-digested and re-analyzed (1)
Laboratory Control Sample Water (LCSW)	One per Digestion Batch of 20 samples or less.	85 – 115% (200.7) 80-120% (6010) (exception Ag and Sb)	If the %R falls outside the acceptable limits, the analysis must be terminated and all associated samples must be re-digested and re-analyzed. The MS may be used in place of the LCS as long as the acceptance criteria are as stringent as for the LCS.

QC ANALYSIS	FREQUENCY	QC CRITERIA	CORRECTIVE ACTION
Laboratory Control Sample Soil (LCSS)	One per Digestion Batch of 20 samples or less.	Must be within the limits established by the manufacturer.	If the percent recovery falls outside the acceptable limits, the analysis must be terminated and all associated samples must be re-digested and re-analyzed. The MS may be used in place of the LCS as long as the acceptance criteria are as stringent as for the LCS.
Matrix Spike (MS)	One per Digestion Batch of 20 samples or less.	70-130% (200.7) 75-125% (6010) EXCEPT for spike samples where the concentration in the unspiked sample exceeds the spike concentration by a factor of 4 or more.	If MS fails criteria sample is qualified with flag. If the LCS was within control limits, MS failure is judged to be matrix related, no further action is required. Job specific see section 9.4.13
Duplicate (DU)	One per Digestion Batch of 20 samples or less.	Lab Limits RPD <20% if sample concentration > 5x the CRDL. ± CRDL rule for sample conc. < 5x the CRDL. For a sample conc. < 5x the CRDL and a DUPLICATE result > 5x the CRDL, the ± rule is used.	The data is flagged if required.
Serial Dilution (SD)	One per analytical sequence / matrix.	Lab Limits ±10%	The data is flagged if the % difference is > 10% and the sample concentration is > 50x the MDL If the sample conc. is <50x the MDL no flag is required.

(1) When MB values constitute 10% or more of the analyte level determined for a sample or is 2.2 times the analyte MDL whichever is greater, fresh aliquots of the samples must be prepared and analyzed again for the affected analytes after the source of contamination has been corrected and acceptable MB values have been obtained. Alternately, the data can be reported with a “b” flag.

11.0 DEFINITIONS

Analytical Batch - shall be defined as environmental samples that are analyzed together with the same method and personnel, using the same lots of reagents, not to exceed the analysis of 20 environmental samples.
Calibration Blank - A volume of reagent water acidified with the same acid matrix as in the calibration standards. The calibration blank is a zero standard and is used to calibrate the ICP instrument.
Calibration Standard (CAL) - A solution prepared from the dilution of stock standard solutions. The CAL solutions are used to calibrate the instrument response with respect to analyte concentration.
Continuing Calibration Verification (CCV) solution or Instrument Performance Check (IPC) Solution – standard used to determine the state of calibration of an instrument between periodic recalibrations.
Daily Performance Check Solution - A solution of method analytes, used to evaluate the performance of the instrument system with respect to a defined set of method criteria.
Dissolved Analyte - The concentration of analyte in an aqueous sample that will pass through a 0.45 μm membrane filter assembly prior to sample acidification.
Field Blank (FB) - An aliquot of reagent water or other blank matrix that is placed in a sample container in the laboratory and treated as a sample in all respects, including shipment to the sampling site, exposure to the sampling site conditions, storage, preservation, and all analytical procedures. The purpose of the FB is to determine if method analytes or other interferences are present in the field environment.
Initial Calibration Verification (ICV) solution - A solution prepared from the dilution of stock standard solutions different from the source of calibration standards. Used to check the calibration. The ICV is satisfying the QCS (Quality Control Sample) requirement as defined in 200.7.
Interference Check Solution (ICS) - A solution of selected method analytes of higher concentrations which is used to evaluate the procedural routine for correcting known interelement spectral interferences with respect to a defined set of method criteria.
Internal Standard (IS) - Pure analyte(s) added to a sample, extract, or standard solution in known amount(s) and used to measure the relative responses of other method analytes that are components of the same sample or solution. The internal standard must be an analyte that is not a sample component.
Laboratory Control Standard (LCS) or Laboratory Fortified Blank (LFB) - An aliquot of reagent water to which known quantities of the method analytes are added in the laboratory. The LCS is analyzed exactly like a sample, and its purpose is to determine whether the methodology is in control and whether the laboratory is capable of making accurate and precise measurements. Note: the matrix spike (MS) may be used in place of this control as long as the acceptance critera are as stringent as for the LCS.
Laboratory Control Standard Duplicate (LCSD) – A second aliquot of reagent water to which known quantities of the method analytes are added in the laboratory and analyzed separately with identical procedures. Analyses of the LCS and LCSD indicates

precision associated with laboratory procedures, but not with sample collection, preservation, or storage procedures.

Linear Range (LR) or Linear Dynamic Range (LDR) - The concentration range over which the instrument response to an analyte is linear.

Limit of Quantitation (LOQ): The lowest concentration that can be reliably achieved within specified limits of precision and accuracy during routine laboratory operating conditions. For many analytes the LOQ analyte concentration is selected as the lowest non-zero standard in the calibration curve.

Matrix Duplicate (MD) or Duplicate (DU) – A second aliquot of the same sample taken in the laboratory and analyzed separately with identical procedures. Analyses of the sample and MD indicates precision associated with laboratory procedures, but not with sample collection, preservation, or storage procedures.

Matrix Spike (MS) or Laboratory Fortified Matrix (LFM) - An aliquot of an environmental sample to which known quantities of the method analytes are added in the laboratory. The MS is analyzed exactly like a sample, and its purpose is to determine whether the sample matrix contributes bias to the analytical results. The background concentrations of the analytes in the sample matrix must be determined in a separate aliquot and the measured values in the MS corrected for background concentrations.

Matrix Spike Duplicate (MSD) - A second aliquot of the same sample to which known quantities of the method analytes are added in the laboratory and analyzed separately with identical procedures. Analyses of the MS and MSD indicates precision associated with laboratory procedures, but not with sample collection, preservation, or storage procedures.

Method Blank (MB) or Laboratory Reagent Blank (LRB)- An aliquot of reagent water or other blank matrices that are treated exactly as a sample including exposure to all glassware, equipment, solvents, reagents, and internal standards that are used with other samples. The MB is used to determine if method analytes or other interferences are present in the laboratory environment, reagents, or apparatus.

Method Detection Limit (MDL) - The minimum concentration of an analyte confirmed by qualitative identification of the analyte(s) in a QC sample in each quality system matrix containing the analyte at no more than 2-3X the MDL for a single analyte tests and 1-4X the MDL for multiple analyte tests that can be identified, measured, and reported with 99% confidence that the analyte concentration is greater than zero but less than the reporting limit (RL). See method SOP for further qualifications.

Method of Standard Addition (MSA) - The addition of a known amount of analyte to the sample in order to determine the relative response of the detector to an analyte within the sample matrix. The relative response is then used to assess either an operative matrix effect or the sample analyte concentration.

Non-conformance Memo (NCM): Memo of an indication, judgment, or state of not having met the requirements of the relevant specifications, contract, or regulation.

Plasma Solution - A solution that is used to determine the optimum height above the work coil for viewing the plasma.

Quality Control Sample (QCS) - A solution of method analytes of known concentrations which is used to fortify an aliquot of MB or sample matrix. The QCS is obtained from a source external to the laboratory and different from the source of calibration standards. It is used to check either laboratory or instrument performance.
Solid Sample - For the purpose of this method, a sample taken from material classified as either soil, sediment or sludge.
Stock Standard Solution - A concentrated solution containing one or more method analytes prepared in the laboratory using assayed reference materials or purchased from a reputable commercial source.
Total Recoverable Analyte - The concentration of analyte determined either by "direct analysis" of an unfiltered acid preserved drinking water sample with turbidity of <1 NTU, or by analysis of the solution extract of a solid sample or an unfiltered aqueous sample following digestion by refluxing with hot dilute mineral acid(s) as specified in the method.
Water Sample - For the purpose of this method, a sample taken from one of the following sources: drinking, surface, ground, storm runoff, industrial or domestic wastewater.

STANDARD OPERATING PROCEDURE

1.0 PROCEDURE TITLE: Analytical Procedure for the Determination of Metals and Trace Elements by Inductively Coupled Plasma-Mass Spectrometry (ICP/MS), Method 200.8 and 6020A.

Approvals and Signatures

Laboratory Manager: Cusack Date: 2/25/13
QA Manager: Maria Date: 2/25/13
Section Supervisor: Maria Date: 2/25/13
EH&S Officer: Date: 2/25/13
Control #: 195

2.0 AREA OF APPLICABILITY: Inorganic Chemistry

3.0 SCOPE: This procedure describes multi-element analysis by ICP-MS based on EPA method 200.8 and SW846 6020A. Method 200.8 lists twenty-one elements for analysis by ICP/MS (Al, Sb, As, Ba, Be, Cd, Cr, Co, Cu, Pb, Mn, Hg, Mo, Ni, Se, Ag, Tl, Th, U, V and Zn). Method SW846 6020A lists 23 elements approved for analysis by ICP/MS (Al, Sb, As, Ba, Be, Cd, Ca, Cr, Co, Cu, Fe, Pb, Mg, Mn, Hg, Ni, K, Se, Ag, Na, Tl, V and Zn).

3.1 Additional elements may be included in this procedure provided that the performance criteria presented in section 10 (Quality Control) and 11 (Method Performance) are met. However, project approval may be required from either a controlling agency or client for compliance testing beyond the elements stated in the promulgated methods.

3.2 This method provides procedures for the determination of dissolved elements in drinking waters, surface waters and ground waters. It may also be used to determine total recoverable elements concentrations in these waters as well as wastewaters, sludge, soil samples and waste extracts.

3.3 With the exception of silver, where this method is approved for the determination of certain metal and metalloid contaminants in drinking water, samples may be analyzed directly by pneumatic nebulization without acid digestion if the sample has been properly preserved with acid and has turbidity <1 NTU at the time of analysis. This total recoverable determination is referred to as "direct analysis".

3.4 The method-reporting limit for most elements measured by this technique is sub-µg/L (<1ppb) to 20ppb. Typical instrument calibration curve covers a working range between 1 - 100µg/L.

4.0 PRINCIPLE

4.1 Well mixed aqueous samples, digestates or leachates are nebulized into a spray chamber where a stream of argon carries the sample aerosol through the quartz torch and injects it into an R.F.plasma. The sample is decomposed and desolvated.

4.2 The ions produced are entrained in the plasma gas and by means of a water-cooled, differentially pumped interface, introduced into a high vacuum chamber that houses a quadrapole mass spectrometer. The ions are sorted according to their mass-to-charge ratio and measured with a detector.

4.3 The mass spectrometer is capable of providing a resolution better than or equal to 1.0 amu peak width at 10% of the peak height for EPA 6020A. For analysis by method 200.8, the resolution requirement is 1 amu at 5% peak height. The ions are sorted according to their mass-to-charge ratio and measured with a channel electron multiplier.

4.4 Interferences must be addressed, assessed and valid corrections applied, or the data flagged to indicate problems. Interference correction must include compensation for background ions contributed by the plasma gas, reagents and the constituents of the sample matrix. Use of the internal standard technique is required by this method to compensate for suppressions and enhancements caused by sample matrices.

5.0 REFERENCES

5.1 "Determination of Trace Elements in Waters and Wastes by Inductively Coupled Plasma-Mass Spectrometry", Revision 5.4, May 1994, Method 200.8

5.2 "USEPA", Revision 1, February 2007, Method SW846 6020A ICP/MS

6.0 SAMPLE HANDLING & PRESERVATION

6.1 Aqueous (total) samples are preserved with nitric acid to a pH of <2 and may be stored in either a glass or plastic container. Preservation must be verified prior to analysis.

6.2 Aqueous (dissolved) samples are filtered through a 0.45um filter, prior to preservation.

6.3 Soil samples do not require preservation, but must be stored at 4°C ± 2°C until time of preparation.

6.4 The holding time for metal samples (aqueous or soils) is 180 days from time of collection.

7.0 INTERFERENCES

7.1 Isobaric elemental Interference- Isobaric elemental interferences in the ICP/MS are caused by isotopes of different elements forming ions with the same nominal mass-to-charge ratio (M/Z). Most interference of this type is corrected for by the instrument software.

7.2 Isobaric Molecular and Doubly Charged Ion Interferences-Isobaric molecular interferences are caused by ions consisting of more than one atom or charge. Most interference of this type is corrected for by the instrument software.

7.3 Physical Interferences – Physical interferences, caused by sample viscosity and surface tension, are associated with the transport and nebulization process. Internal standards are used to compensate for these types of interferences.

7.3.1 Internal Standards (IS) should be added at a level to give approximately 200,000 – 800,000 counts of raw signal intensity. Target intensity is 300,000 counts. The mass of the IS should be within 50 amu of the mass of the measured element.

7.3.2 Matrix effects will be monitored by comparing the IS intensity in the sample to the IS of the calibration blank.

7.3.2.1 When performing field samples analysis by method 6020A, the relative intensity (RI) must be between 70 –125% of the initial calibration. If field samples fall outside of this range check the calibration blank (CCB). If the intensities are within criteria, dilute the sample 5x dilution to correct for matrix effect. Perform dilution until criteria is met.

7.3.2.2 For method 200.8, RI of IS must be between 60 and 125% of the calibration blank. If the sample(s) RI is outside this window, check the calibration blank (CCB). If the intensities are within criteria, dilute the sample 2x and reanalyze. Perform dilution until criteria is met. Case narrate anomaly if necessary. Note: for drinking water samples, it is highly unusual for the IS to fail, primarily due to lack of matrix interference in a DW sample.

7.3.3 Memory effects are dependant on the relative concentration differences between samples and/or standards that are being analyzed sequentially. The rinse period between samples must be long enough to eliminate significant memory interference.

7.3.4 Analytical Note: Dissolved solids, deposited on the nebulizer tip and/or interface skimmers during sample processing will adversely affect instrument performance. A final total solids concentration below 0.2% (2000 mg/l) is recommended to optimize system performance.

7.3.5 High salt concentrations (e.g., seawater samples) cause analyte signal suppression or enhancement, dependent upon the element. Samples with high salt content can cause both physical interference and isobaric molecular interferences

7.4 The use of Hydrochloric and Sulfuric acids should be minimized due to higher incidence of molecular-ion interferences with the presence of these acids. Excessive amounts of nitric acid can also lead to molecular interferences.

8.0 APPLICABLE/ASSOCIATED SOPS

8.1 Safety

8.1.1 Employees must abide by the policies and procedures in the Corporate Safety Manual.

8.1.2 Specific Safety Concerns or Requirements

8.1.2.1 The ICP plasma emits strong UV light and is harmful to vision. All analysts must avoid looking directly at the plasma. The ICP RF generator produces strong radio frequency waves, most of which are unshielded. People with pacemakers should not go near the instrument while in operation.

8.1.3 Primary Materials Used

8.1.3.1 The following is a list of the materials used in this method, which have a serious or significant hazard rating. **NOTE: This list does not include all materials used in the method. The table contains a summary of the primary hazards listed in the MSDS for each of the materials listed in the table.** A complete list of materials used in the method can be found in the reagents and materials section. Employees must review the information in the MSDS for each material before using it for the first time or when there are major changes to the MSDS.

Material (1)	Hazards	Exposure Limit (2)	Signs and symptoms of exposure
Nitric Acid	Corrosive Oxidizer Poison	2 ppm-TWA 4 ppm-STEL	Nitric acid is extremely hazardous; it is corrosive, reactive, an oxidizer, and a poison. Inhalation of vapors can cause breathing difficulties and lead to pneumonia and pulmonary edema, which may be fatal. Other symptoms may include coughing, choking, and irritation of the nose, throat, and respiratory tract. Can cause redness, pain, and severe skin burns. Concentrated solutions cause deep ulcers and stain skin a yellow or yellow-brown color. Vapors are irritating and may cause damage to the eyes. Contact may cause severe burns and permanent eye damage.
Hydrochloric Acid	Corrosive Poison	5 ppm-Ceiling	Inhalation of vapors can cause coughing, choking, inflammation of the nose, throat, and upper respiratory tract, and in severe cases, pulmonary edema, circulatory failure, and death. Can cause redness, pain, and severe skin burns. Vapors are irritating and may cause damage to the eyes. Contact may cause severe burns and permanent eye damage.
1 – Always add acid to water to prevent violent reactions.			
2 – Exposure limit refers to the OSHA regulatory exposure limit.			

8.2 Pollution Prevention

8.1.4 This method does not contain any specific modifications that serve to prevent or minimize pollution.

8.3 Waste Management

8.3.1 Waste generated in this procedure must be segregated and disposed according to the ETL's facility hazardous waste procedures. The Environmental Health and Safety Officer should be contacted if additional information is required.

9.0 PROCEDURE

9.1 Apparatus

9.1.1 Argon Gas: high purity grade (99.99%)

9.1.2 ICP/MS capable of scanning the mass range 5-250 amu providing a resolution less than or equal to 1 AMU at 5% peak height with a data system that allows corrections for isobaric interferences and the application of the internal standard technique.

9.1.3 A multiple channel peristaltic pump.

9.1.4 A water chilled cooler.
9.1.5 Calibrated pipettes.
9.1.6 Auto-sampler with a/s disposable tubes, variable speed.
9.1.7 An electron multiplier detector.

9.2 PREPARATION OF WATER QUALITY REAGENTS

9.2.1 Storage and Shelf life

9.2.1.1 All standards must be stored in previously unused polyethylene or polypropylene containers. Standards stored at concentrations as received from an outside vendor must be replaced prior to the vendor's expiration dated provided. If no expiration date is provided, the standards may be stored up to one year from receipt. Standards must be replaced sooner if verification from an independent source indicates a problem.

Note: Standards at other concentrations may be used and prepared as needed.

9.2.2 The tuning solution is purchased as a multi-element mix. The final concentrations typically used are 10µg/L of: Ba, Be, Ce, Co, In, Pb, Mg and Rh, U is added at 10ug/L using dilute nitric acid (1%).

9.2.3 The initial calibration standards are purchased as a multi-element mix. The standards are diluted to working levels using dilute nitric acid (1%). The mix may be either a 10 or 20mg/L solution (50 or 100mg/L for Se).

NOTE: Calibration standards must be re-made every two weeks or as needed.

9.2.4 ICV- The ICV standards are obtained from an independent (different) source that the calibration standards. The ICV is prepared to a concentration of <100ug/l using dilute nitric acid (1%).

NOTE: ICV/CCV standards must be prepared quarterly or as needed.

9.2.5 CCV – The CCV standards is the same source as the calibration standards prepared at a different concentration from the ICV. The CCV standards are prepared in dilute nitric acid (1%).

9.2.6 The Reporting Limit (RL) Verification standard can be prepared from the same stock as the calibration standards in dilute nitric acid. The RL standards must be equal to the concentration of the reporting limit prepared in dilute nitric acid (1%).

9.2.7 The LCS/MS spiking solutions are purchased as a multi-element mix. The standards are diluted to working levels using dilute nitric acid (1%). The mix may be either a 10 or 20mg/L solution (50 or 100mg/L for Se).

9.2.8 Reagent Water: ASTM Type I for the elements of interest, generated from the lab's AquaPure de-ionization system capable of achieving 18.0 megohm-cm.

9.2.9 Internal Standard Solution – Internal standard solutions are purchased as a multi-element mix and diluted to working levels using dilute nitric acid

(1%). The mix includes all internal standards used in the method.

9.2.10 Interference check solution –

Note: Prepare weekly, analyst should be aware Ag in solution AB may precipitate more quickly.

9.2.10.1 Interference Check Solution A (ICSA)

9.2.10.1.1 Add 10ml ICP-MS-ICS-3 solution A (High Purity or equivalent) to 100ml using.dilute nitric acid (1%).

9.2.10.2 Interference Check Solution AB (ICSAB)

9.2.10.2.1 Add 10ml ICP-MS-ICS-3 solution A and 1ml ICP-MS-ICS-3 solution B (High Purity or equivalent) to 100ml using.dilute nitric acid (1%).

9.2.11 Blanks –

9.2.11.1 Calibration blank: 1% nitric acid solution.

9.2.11.2 Method blank: 1% nitric acid solution carried though the complete procedure as the samples (including filtration if dissolved)

9.2.11.3 Rinse blank: 2% Nitric solution to flush system.

9.3 Instrument Startup ELAN 6100

9.3.1 Switch on the PC (the monitor, printer and autosampler are usually left on.

9.3.2 Ensure that the pump rollers of the peristaltic pump are clean and able to move freely.

9.3.3 Connect the pump tubing (both of the thin sample tubing and the thicker drain tubing) on the peristaltic pump, making sure that the flow of sample and waste will be in the correct direction. If the pump tubing is new, stretch it gently before attaching. If the pump tubing has been used previously, check it for flat spots, discoloration, brittleness and clogging. The pump tubing must be replaced regularly.

9.3.4 Replace the tubing clamps for each pump channel and swing the cam arm to close and apply tension to the clamps.

9.3.5 Place the sample capillary tube into a container of ~2 % HNO_3 rinse wash solution.

9.3.6 Click on the *Instrument icon* and then, if necessary, on the *Front Panel button* to open the ELAN control panel. The System Status indicator should indicate "*Ready*" if all of the system hardware components are operating properly. If the System Status indicator says "*Not Ready*", click on the *Diagnostics button* to determine the cause of the problem.

9.3.7 Make sure the exhaust fan is on. If this is not done, the instrument will overheat and shut itself down within a few minutes.

9.3.8 If necessary switch on the peristaltic pump as follows: Click on the *Devices icon*. Click on the *Connect button*. Click on the *arrow button*.

Check that the solution is flowing properly to the nebulizer and spray chamber, as well as to the waste container. Starting the pump before igniting the plasma fills the nebulizer and plasma torch with water vapor, thus removing any air pockets and ensuring a good first-time plasma ignition, which avoids puttering of the RF load coil onto the plasma torch.

9.3.9 To ignite the plasma, click on the *Plasma Start button* on the instrument control panel. The progress of the ignition sequence, which requires a little over a minute to complete, is depicted in the Ignition Sequence status bar. If necessary (the instrument has not been used for an extended period of time (i.e. more than two days), or if the nebulizer and/or spray chamber and/or plasma torch have been replaced), the ignition process may be stopped after about 75 % of the ignition sequence has been completed by clicking on the *Plasma Stop button.* After waiting for 15 seconds, click on the *Plasma Start button* again to ignite the plasma. This procedure allows for removal of excess air and improves plasma ignition.

9.3.10 Allow the instrument to warm up for approximately 15-30 minutes. The torch box temperature should reach about 44°C. Optimization may proceed while the instrument's warming up.

9.4 Instrument Shut Down

9.4.1 Before shutting down the instrument, aspirate ~2 % HNO_3 wash solution for 15 minutes to clean out the sample introduction system.

9.4.2 Remove the sample capillary tube or autosampler probe from the ~2 % HNO_3 wash solution.

9.4.3 Click on the *Instrument icon* and then click on the *Plasma Stop button.*

9.4.4 Release the peristaltic pump tubing (both the sample, IS, drain and autosampler rinse tubing).

9.4.5 Close all ELAN software windows and the ELAN software itself. Then power off/shut down the PC.

9.5 Daily Optimization -The following optimizations procedures should be performed daily.

9.6 Perform Daily Performance Check

9.6.1 Frequency: Daily, before and after Tune/ Mass Calibration.

9.6.2 Daily performance standard should be a 10 µg/L standard of 3 or more elements representative of the analytical mass range. Its purpose is to check sample introduction; sensitivity; oxide and double charge interferences. This is a multiple check on instrument performance suggested by the manufacturers.

Manufacturer's recommended criterion*:
Background < 30cps @ Mass 220
In Sensitivity >300,000 cps

Mg Sensitivity > 40,000 cps
Pb Sensitivity >100,000 cps
CeO/Ce < 3%
Ba++/Ba+ < 3%
Net intensities < 5%

*Poor sensitivity or gradual loss of sensitivity may be indicative that the sample and skimmer cones requiring cleaning or replacement. Cones can be cleansed with a 1% nitric acid wash or sonicated in a hot water bath for 5 minutes. Air dry before reinstalling.

9.6.3 If Daily Performance Standard exceeds 3% criterion; perform instrument maintenance and re-run standard.

9.7 Perform Instrument Tune/ Mass Calibration Tune the instrument with the tuning solution containing elements representing all the mass regions of interests.

For 6020A the mass calibration criteria must be ≤ 0.1 amu difference from true, and resolution < 0.9 amu full width at 10% peak height. If the mass calibration differs more than 0.1 amu from the true value, then the mass calibration must be adjusted to the correct value.

For 200.8, the method suggests to adjust spectrometer resolution to produce a peak width of approximately 0.75 amu at 5% peak height. Adjust mass calibration if it has shifted by more than 0.1 amu from unit mass.

9.8 Perform Daily Performance Check

9.8.1 Frequency. Daily, before and after instrument mass calibration. (See section 9.6)

9.9 Initial Calibration. Calibrate the ICP/MS daily with a minimum of a blank and three non-blank standards, which may include a RL and LR standard. Method 200.8 allows for only a calibration blank and a single point calibration standard. Both methods require triplicate integrations, with the average result to be reported.

9.10 Analyze the ICV solution (independent source from the calibration standards) immediately after initial calibration. Acceptance criteria is 90-110% of known value. Spike the solution near mid-range of the analytical curve (~50ppb). (See IS required recovery on this standard in section "Quality Control").

9.11 Analyze ICB. Results must be < RL.

9.12 Analyze CRI (if not part of cal curve), ICSA/AB (for 6020A) followed by CCV and CCB.

9.13 Analyze Method blank, LCS, LCSD (if required), Samples, MS, MSD (if required) and MD.

9.14 Analyze Serial Dilution (1 per 20 samples, 5x dilution for method 6020A).

9.15 Analyze CCV, CCB every 10 samples and at close of analytical run.

9.16 Preparation of Samples-

9.16.1 Dissolved and Drinking water (if turbidity <1 NTU) samples may be analyzed as received.

9.16.2 Samples requiring Total aqueous analysis and Soils/sediments are digested prior to analysis.

9.17 Analysis of Samples

9.17.1 Report the average of three integrations. Flush the system with a rinse blank between samples and standards during the analytical run.

9.17.2 Dilute and reanalyze any element that exceeds the concentration range of the upper calibration curve.

For samples with Ag > 100µg/L, prepared digestion until contains < 100µg/L Ag 3/27/13

10.0 QUALITY CONTROL

10.1 Ongoing data quality control checks are compared with method established performance criteria to determine if the instrument and results meet performance characteristics of the method. Control chart limits are maintained by the laboratory's LIMS and may be consulted to understand trends in QC samples, however control charts limits shall not exceed method-defined limits. Initial Demonstration of Capability (IDOC) is required prior to analyzing client's field samples. Annual MDLs (< RL) are mandatory and must be kept on file.

10.2 Method Blanks (MB) - One method blank must be processed per batch (20 samples or less). The MB results must be less than the reporting limit (RL). If a MB results does not meet this criteria, the source of the contamination should be determined and the problem corrected. The following corrective actions may be utilized when the MB does not meet criteria:

- The same analyte was not detected in the associated samples
- The MB concentration was 1/10 of the concentration found in the sample

Note: if the above criteria are not met and reanalysis is not possible, then the data must be qualified in the report's case narrative and the client notified.

When MB analyte values are 2.2 times the analyte MDL but < RL any sample analyte not <RL or 10 times greater than the MB must be flagged with 'b'.

10.3 LCS- One LCS must be processed with each preparation batch (LCS/LCSD if client specified). The acceptance criteria for the LCS is 85-115%R for method 200.8, and 80-120%R for method 6020A. (LCS/LCSD RPD must not exceed 20%). The following corrective actions may be utilized when the LCS does not meet criteria:

If the LCS exceeds these limits for any analyte, that analyte is judged to be out of control. All associated samples must be reprocessed for analysis. One exception to this rule is that if the LCS recovered above control criteria, and no target analyte was detected in the sample, then the data may be reported with a QC memo (NCM).

10.4 MS/MSD- One pair of MS/MSD or MS/MD must be processed with each QC batch. The control criteria are not to exceed 70-130%R for method 200.8 and 75 –125% for method 6020A and 20% RPD for aqueous samples. Corrective action when criteria are not met is to verify that the LCS was within control. If within control limits, no further action is required.

10.5 ICSA/AB – Interference Check Standard A & AB monitors the adequacy of isobaric interference corrections and if needed must be analyze at the beginning of the analytical run. The % recovery should fall within 80 – 120% of the spiked values. There is no corrective action required for this standard because instrument corrections are based on natural isotope abundances that cannot be changed. If elements fall outside of these criteria, case narrate non-compliances. These standards are only required for SW846 6020A analysis.

10.6 Serial Dilution Test – One dilution test is required per 20 field samples only if the analyte concentration is > 10x the RL. The dilution test measures the effect from sample matrix. Perform a 5x dilution and the difference between the undiluted sample and DF corrected sample should be ± 10%. No corrective action is required for out of control situations.

10.7 IS – Internal Standards measure the effect of the sample matrix. The IS is added to each field sample and QC sample. For SW846 6020A, the IS must recover between 70-125% of the relative intensity (RI) of the calibration blank. For method 200.8, the IS must be between 60-125% of the RI of the calibration blank. If outside of limits, reanalyze the calibration blank to confirm that the instrument has not drifted out of control. If CCB criteria met, dilute samples 2x and re-analyze. Samples must be diluted until IS control criteria is met.

10.8 PDS- Post digested Spike addition for method SW846 6020A is performed if ms recovery is unacceptable. An analytical spike is added to a portion of a prepared sample (or its dilution) and should recover between 80 – 120% of known valve. If the PDS fails to meet this criterion, matrix interference should be suspected.

10.9 QC CRITERIA SUMMARY TABLE

QC Analysis	**Frequency**	**QC Criteria**	**Corrective Action**
Initial Demonstration of Capability (IDOC)	At least 4 aliquots of standard 1-4 Xs reporting limit shall be prepared and analyzed as per method either concurrently or over a period of days. This must be done for all new personnel and at any time there is a change in instrumentation or method.	Mean recovery 85-115% Standard Deviation ≤ 10.0%	Repeat procedure using fresh samples until satisfactory performance is demonstrated. (May need to optimize instrument settings. See manufactures instructions.)
Linear dynamic range (LDR)	At start up then verified annually or whenever, in the judgment of the analyst, a change in operating conditions would dictate.	Within 10% of standard value	Samples above 90% of the LDR must be diluted and reanalyzed.
Method Detection Limit Study (MDL)	Prepare 7 spike samples at a concentration 1 to 4 times the suspected MDL at method start-up and then annually.	Calculate mean recovery and standard deviation.	See MDL SOP
Daily Performance Standard	Daily	See sec.9.6	Perform instrument maintenance and rerun standard. See instrument manual.
Tuning	Daily	See sec. 9.7	Re-optimize
Initial Calibration	Following tuning and prior to sample analysis [Minimum of blk, plus (3) non blk stds]	r = ≥ 0.998	Re-calibrate

QC Analysis	Frequency	QC Criteria	Corrective Action
ICV (Initial Calibration Verification)	Once at start of analytical run	90-110%	Recalibrate. Re-check ICV; if still unacceptable, investigate possible calibration std or ICV out of specification.
ICB (Initial Calibration Blank)	Once at start of analytical run	< RL	Recalibrate. Re-check ICB; if still unacceptable, investigate possible contamination of reagents, Milli-Q water.
Reporting Limit Calibration Check Standard (CRI)	Daily, if not part of calibration curve (also at end for 6020A)	70-130% (6020A)	Recalibrate, re-analyze
ICSA/AB	Daily at beginning of analytical run for 6020A	80-120% (6020A)	No action required.
CCV (Continuing Calibration Verification)	Every 10 samples or fraction thereof	85-115% (200.8) 90-110% (6020A)	If unacceptable, re-analyze; if still out recalibrate. Sample values for blocks between acceptable CCVs may be reported; those that are not must be rerun.
CCB (Continuing Calibration Blank)	Every 10 samples or fraction thereof	< RL	If unacceptable, re-analyze; if still out recalibrate. Sample values for blocks between acceptable CCB may be reported; those that are not must also be rerun.
Method Blank (MB)*	One per batch of 20 samples	See Sec. 10.2 <RL	See Section 10.2 Re-analyzed, Re-digest*
LCS	Once per batch of 20 Samples or fraction thereof	85-115% (200.8) 80-120% (6020A)	If unacceptable, re-analyze; if still out recalibrate or re-digest sample batch.
LCSD	Once per batch of 20 Samples or fraction thereof (if required by client)	80-120% (6020A) ≤20% RPD	If unacceptable, re-analyze; if still out recalibrate or re-digest sample batch.

QC Analysis	Frequency	QC Criteria	Corrective Action
Matrix Duplicate (MD)	Every 20 samples or fraction thereof	RPD ≤20%	The data is flagged if required.
Matrix Spike (MS)	Every 20 samples or fraction thereof	70-130% (200.8) 75-125%- (6020A)	If unacceptable, review LCS. If LCS acceptable, no corrective action require- matrix effect suspected.
Internal Standards (IS)	IS added to all QC and field samples	60-125% (200.8) 70% (6020A)	Check CCB, if w/in limits perform dilution and re-analyze
Dilution Test (SD)	Every Batch	Dilute 5x +/- 10% for analytes > 10 RL	None

*When MB analyte values are 2.2 times the analyte MDL but < RL any sample analyte not <RL or 10 times > MB must be flagged with 'b'.

10.10 CALCULATION

10.10.1 Data Calculations

ICV/CCV percent recoveries are calculated according to the equation:

$$\%R = 100 \times \frac{(\text{Found ICV/CCV})}{(\text{True ICV/CCV})}$$

The final concentration for an aqueous sample is calculated as follows:

$$\text{Result } (\mu g/L) = \frac{(C \times V1 \times D)}{V2}$$

Where:

C = Concentration from instrument readout, ppb
D = Instrument dilution factor
V1 = Final volume in liters after sample preparation
V2 = Initial volume of sample digested in liters

Matrix Spike Recoveries are calculated according to the following equation:

$$\%R = 100 \times \frac{(SSR - SR)}{SA}$$

Where:

SSR = Spiked Sample Result
SR = Sample Result
SA = Spike Added

Note – When sample concentration is less than the detection limit, use SR = 0 for the purposes of calculating %R.

The Relative Percent Difference (RPD) of a sample duplicate is calculated according to the following equation:

$$RPD = 100 \times \frac{|(DU1 - DU2)|}{(DU1 + DU2) / 2}$$

Where:

DU1 = Sample result
DU2 = Sample duplicate result

11.0 METHOD PERFORMANCE

11.1 The group supervisor has the responsibility to ensure that this procedure is performed by an associate who has been properly trained in its use and has the required experience.

11.2 Method Detection Limit Study (MDL). An initial detection limit study must be performed on the instrument before samples can be analyzed. MDL studies are conducted annually.

11.3 Initial Demonstration of Capability (IDOC). All personnel are required to perform an IDOC proficiency on the instrument they will be using for analysis prior to testing client samples. On-going proficiency must be demonstrated annually.

12.0 DEFINITIONS

Analytical Batch - shall be defined as environmental samples that are analyzed together with the same method and personnel, using the same lots of reagents, not to exceed the analysis of 20 environmental samples.

Calibration Blank - A volume of reagent water acidified with the same acid matrix as in the calibration standards. The calibration blank is a zero standard and is used to calibrate the ICP instrument.

Calibration Standard (CAL) - A solution prepared from the dilution of stock standard solutions. The CAL solutions are used to calibrate the instrument response with respect to analyte concentration.

Continuing Calibration Verification (CCV) solution or Instrument Performance Check (IPC) Solution – standard used to determine the state of calibration of an instrument between periodic recalibrations.

Daily Performance Check Solution - A solution of method analytes, used to evaluate the performance of the instrument system with respect to a defined set of method criteria.

Dissolved Analyte - The concentration of analyte in an aqueous sample that will pass through a 0.45 µm membrane filter assembly prior to sample acidification.

Field Blank (FB) - An aliquot of reagent water or other blank matrix that is placed in a sample container in the laboratory and treated as a sample in all respects, including shipment to the sampling site, exposure to the sampling site conditions, storage, preservation, and all analytical procedures. The purpose of the FB is to determine if method analytes or other interferences are present in the field environment.

Initial Calibration Verification (ICV) solution - A solution prepared from the dilution of stock standard solutions different from the source of calibration standards. Used to check the calibration. The ICV is also known as the QCS (Quality Control Sample).

Interference Check Solution (ICS) - A solution of known concentrations of interfering elements that will demonstrate the magnitude if interferences and provide an adequate test of corrections. The ICS is used to verify that the interference levels are corrected by the data system within control limits.

Internal Standard (IS) - Pure analyte(s) added to a sample, extract, or standard solution in known amount(s) and used to measure the relative responses of other method analytes that are components of the same sample or solution. The internal standard must be an analyte that is not a sample component.

Laboratory Control Standard (LCS) or Laboratory Fortified Blank (LFB) - An aliquot of reagent water to which known quantities of the method analytes are added in the laboratory. The LCS is analyzed exactly like a sample, and its purpose is to determine whether the methodology is in control and whether the laboratory is capable of making accurate and precise measurements. Note: the matrix spike (MS) may be used in place of this control as long as the acceptance critera are as stringent as for the LCS.

Laboratory Control Standard Duplicate (LCSD) – A second aliquot of reagent water to which known quantities of the method analytes are added in the laboratory and analyzed separately with identical procedures. Analyses of the LCS and LCSD indicates precision associated with laboratory procedures, but not with sample collection, preservation, or storage procedures.

Linear Range (LR) or Linear Dynamic Range (LDR) - The concentration range over which the instrument response to an analyte is linear.

Limit of Quantitation (LOQ): The lowest concentration that can be reliably achieved within specified limits of precision and accuracy during routine laboratory operating conditions. For many analytes the LOQ analyte concentration is selected as the lowest non-zero standard in the calibration curve.

Matrix Duplicate (MD) or Duplicate (DU) – A second aliquot of the same sample taken in the laboratory and analyzed separately with identical procedures. Analyses of the sample and MD indicates precision associated with laboratory procedures, but not with sample collection, preservation, or storage procedures.

Matrix Spike (MS) or Laboratory Fortified Matrix (LFM) - An aliquot of an environmental sample to which known quantities of the method analytes are added in the laboratory. The MS is analyzed exactly like a sample, and its purpose is to determine whether the sample matrix contributes bias to the analytical results. The background concentrations of the analytes in the sample matrix must be determined in a separate aliquot and the measured values in the MS corrected for background concentrations.

Matrix Spike Duplicate (MSD) - A second aliquot of the same sample to which known quantities of the method analytes are added in the laboratory and analyzed separately with identical procedures. Analyses of the MS and MSD indicates precision associated with laboratory procedures, but not with sample collection, preservation, or storage procedures.

Method Blank (MB) or Laboratory Reagent Blank (LRB)- An aliquot of reagent water or other blank matrices that are treated exactly as a sample including exposure to all glassware, equipment, solvents, reagents, and internal standards that are used with other samples. The MB is used to determine if method analytes or other interferences are present in the laboratory environment, reagents, or apparatus.

Method Detection Limit (MDL) - The minimum concentration of an analyte confirmed by qualitative identification of the analyte(s) in a QC sample in each quality system matrix containing the analyte at no more than 2-3X the MDL for a single analyte tests and 1-4X the MDL for multiple analyte tests that can be identified, measured, and reported with 99% confidence that the analyte concentration is greater than zero but less than the reporting limit (RL). See method SOP for further qualifications.

Non-conformance Memo (NCM): Memo of an indication, judgment, or state of not having met the requirements of the relevant specifications, contract, or regulation.

Solid Sample - For the purpose of this method, a sample taken from material classified as either soil, sediment or sludge.

Stock Standard Solution - A concentrated solution containing one or more method analytes prepared in the laboratory using assayed reference materials or purchased from a reputable commercial source.

Total Recoverable Analyte - The concentration of analyte determined either by "direct analysis" of an unfiltered acid preserved drinking water sample with turbidity of <1 NTU, or by analysis of the solution extract of a solid sample or an unfiltered aqueous sample following digestion by refluxing with hot dilute mineral acid(s) as specified in the method.

Water Sample - For the purpose of this method, a sample taken from one of the following sources: drinking, surface, ground, storm runoff, industrial or domestic wastewater.

TABLE 1

Suggested Mass Choices

Boldface masses indicate the masses which must have the most impact on data quality and the elemental equations used to collect the data. Suggested masses for method 200.8 are in "quotes".

Mass	**Element of Interest**
"27"	Aluminum
121, **"123"**	Antimony
"75"	Arsenic
138, "137", 136, **135**, 134, 132, 130	Barium
"9"	Beryllium
114, 112, "111", 110, 113, 116, 106	Cadmium
42, 43, **44**, 46, 48	Calcium
"52", 53, 50, 54	Chromium
"59"	Cobalt
"63", 65	Copper
56, 54, 57, 58	Iron
"208", "207", "206", 204	Lead
24, **25, 26**	Magnesium
"55"	Manganese
58, **"60"**, 62, **61**, 64	Nickel
39	Potassium
80, **78, "82"**, 76, **77**, 74	Selenium
"107", 109	Silver
23	Sodium
"205", 203	Thallium
"51", 50	Vanadium
64, **"66", 68, 67**, 70	Zinc
72	Germanium
139	Lanthanum
118	Tin
35, 37	Chlorine
"98", 96, 92, **97**, 94	Molybdenum

Note: It is strongly recommended that elements other than those of interest be monitored to indicate other potential molecular interferences which could affect the data quality.

STANDARD OPERATING PROCEDURE

1.0 PROCEDURE TITLE: Inorganic Anions, IC

Approvals and Signatures

Laboratory Manager: Renée Cusack Date: 9/18/13
QA Specialist: Date: 9/18/13
Section Supervisor: Renée Cusack Date: 9/18/13
EH&S Officer: Date: 9/18/13
Control #: 110

2.0 AREA OF APPLICABILITY: Inorganic Chemistry

3.0 SCOPE:

This method is applicable to the determination of sulfate, bromide, nitrite, ortho-phosphate, fluoride, chloride, and nitrate in drinking water, surface water, and mixed domestic and industrial wastewater.

4.0 PRINCIPLE:

A small volume of sample is introduced into an ion chromatograph. The anions of interest are separated and measured, using a system comprised of a guard column, separator column, suppressor, and conductivity meter.

5.0 REFERENCES

5.1 "Methods for Chemical Analysis of Water and Wastes" EPA-600 /R-93-100, August 1993.

6.0 PRESERVATION AND HOLD TIME:

Samples can be collected in plastic or glass. Sample preservation and holding times for the anions that can be determined by this method are as follows:

Analyte	Preservation	Holding Time
Bromate	None required	28 days
Bromide	None required	28 days
Chlorate	None required	28 days
Chloride	None required	28 days
Chlorite	Cool to 4 C	Immediately
Fluoride	None required	28 days
Nitrate-N	Cool to 4 C	48 hours

Analyte	Preservation	Holding Time
Nitrite-N	Cool to 4 C	48 hours
0rtho-Phosphate-P	Cool to 4 C	48 hours
Sulfate	Cool to 4 C	28 days

7.0 INTERFERENCES:

7.1 Interferences can be caused by substances with retention times that are similar to and overlap those of the anion of interest. Large amounts of an anion can interfere with the peak resolution of an adjacent anion. Sample dilution and/or fortification can be used to solve most interference problems associated with retention times.

7.2 The water dip or negative peak that elutes near, and can interfere with, the fluoride peak can usually be eliminated by the addition of the equivalent of 1mL of concentrated eluent (7.3 100X) to 100 mL of each standard and sample.

7.3 Method interferences may be caused by contaminants in the reagent water, reagents, glassware, and other sample processing apparatus that lead to discrete artifacts or elevated baseline in ion chromatograms.

7.4 Samples that contain particles larger than 0.45µ and reagent solutions that contain particles larger than 0.20µ require filtration to prevent damage to instrument columns and flow systems.

7.5 Any anion that is not retained by the column or only slightly retained will elute in the area of fluoride and interfere. Known coelution is caused by carbonated and other small organic anions. At concentrations of fluoride above 1.5 mg/L, this interference may not be significant, however, it is the responsibility of the user to generate precision and accuracy information in each sample matrix.

7.6 The acetate anion elutes early during the chromatographic run. The retention times of the anions also seem to differ when large amounts of acetate are present. Therefore, this method is not recommended for leachates of solid samples when acetic acid is used for pH adjustment.

7.7 The quantitation of unretained peaks should be avoided, such as low molecular weight organic acids (formate, acetate, propionate etc.) which are conductive and coelute with or near fluoride and would bias the fluoride quantitation in some drinking and most waste waters.

7.8 Any residual chlorine dioxide present in the sample will result in the formation of additional chlorite prior to analysis. If any concentration of chlorine dioxide is suspected in the sample purge the sample with an inert gas (argon or nitrogen) for about five minutes or until no chlorine dioxide remains.

7.9 Substances with retention times similar to and overlap those of an anion of interest. Because many anions interfere, use an ion-exchange column to remove interferences.

8.0 APPLICABLE/ASSOCIATED SOPS

8.1 Safety

8.1.1 Employees must abide by the policies and procedures in the Corporate Safety Manual and this document.

8.1.2 Specific Safety Concerns or Requirements

8.1.2.1 Sodium Fluoride is Highly Toxic.

8.1.2.2 Exercise caution when using syringes with attached filter assemblies. Application of excessive force has, upon occasion, caused a filter disc to burst during the process.

8.1.3 Primary Materials Used

8.1.3.1 The following is a list of the materials used in this method, which have a serious or significant hazard rating. NOTE: This list does not include all materials used in the method. The table contains a summary of the primary hazards listed in the MSDS for each of the materials listed in the table. A complete list of materials used in the method can be found in the reagents and materials section. Employees must review the information in the MSDS for each material before using it for the first time or when there are major changes to the MSDS.

Material (1)	**Hazards**	**Exposure Limit (2)**	**Signs and symptoms of exposure**
Potassium Nitrate	Oxidizer	None	Causes irritation to the respiratory tract, skin and eyes. Symptoms may include coughing, shortness of breath. Symptoms include redness, itching, and pain.
Sodium Fluoride	Poison	2.5 Mg/M3-TWA as F	**Highly Toxic.** Causes severe irritation to the respiratory tract, symptoms may include coughing, sore throat, and labored breathing. Causes irritation, with redness and pain. Solutions are corrosive. Eye irritant! May cause irritation and serious eye damage. Effects may not appear immediately.
Sulfuric Acid	Corrosive Oxidizer Dehydrator Poison Carcinogen	1 Mg/M3-TWA	Inhalation produces damaging effects on the mucous membranes and upper respiratory tract. Symptoms may include irritation of the nose and throat, and labored breathing. Symptoms of redness, pain, and severe burn can occur. Contact can cause blurred vision, redness, pain and severe tissue burns. Can cause blindness.
1 – Always add acid to water to prevent violent reactions.			
2 – Exposure limit refers to the OSHA regulatory exposure limit.			

8.2 WASTE MANAGEMENT AND POLLUTION PREVENTION

8.2.1 All waste will be disposed of in accordance with Federal, State and Local regulations. Where reasonably feasible, technological changes have been implemented to minimize the potential for pollution of the environment. Employees will abide by this method and the policies in section 13 of the Corporate Safety Manual for "Waste Management and Pollution Prevention."

8.2.2 Waste Streams Produced by the Method

8.2.2.1 The following waste streams are produced when this method is carried out.

8.2.2.1.1 Alkaline and/or acidic waste generated by the analysis is collected and discarded down the acid-neutralizing sink.

8.2.2.1.2 Contaminated plastic materials such as IC syringes, filters, caps and vials utilized for sample preparation are rinsed with water and discarded in the garbage.

9.0 PROCEDURE

9.1 Reagents

9.1.1 Sulfate Stock Solution
9.1.1.1 Purchased from IC Cal Standards or equivalent
9.1.1.2 Concentration=1000mg/L

9.1.2 Nitrate Stock Solution
9.1.2.1 Purchased from High Purity or equivalent
9.1.2.2 Concentration=100mg/L

9.1.3 Bromide Stock Solution
9.1.3.1 Purchased from High Purity or equivalent
9.1.3.2 Concentration=100mg/L

9.1.4 Chloride Stock Solution
9.1.4.1 Purchased from High Purity or equivalent
9.1.4.2 Concentration=100mg/L

9.1.5 Fluoride Stock Solution
9.1.5.1 Purchased from High Purity or equivalent
9.1.5.2 Concentration=100mg/L

9.1.6 Nitrite Stock Solution
9.1.6.1 Purchased from High Purity or equivalent
9.1.6.2 Concentration=100mg/L

9.1.7 Ortho-Phosphate Solution
9.1.7.1 Phosphorus solution purchased from High Purity or equivalent
9.1.7.2 Concentration=100mg/L

9.1.8 Anion Eluent

9.1.8.1 For AS4A Column

9.1.8.1.1 10x concentrate: Dissolve 6.732g sodium carbonate (Na_2CO_3) and 5.01g sodium hydrogen carbonate ($NaHCO_3$) in distilled water and dilute to 3.5 liters.

9.1.8.1.2 Working solution: Dilute 350mL concentrated Eluent to 3.5L with DI water.

9.1.8.2 For AS14 Column

9.1.8.2.1 Dissolve 1.309 g Na_2CO_3 and 0.2947g $NaHCO_3$ in distilled water and dilute to 3.5 liters.

9.2 Apparatus

9.2.1 Balance - Analytical, capable of accurately weighing to the nearest 0.0001 g.

9.2.2 Dionex Ion chromatograph with Data System

9.2.3 Analytical system complete with ion chromatograph and all required accessories including syringes, analytical columns, compressed gasses and detectors.

9.2.4 Anion guard column: A protector of the separator column. If omitted from the system the retention times will be shorter. Usually packed with a substrate the same as that in the separator column.

9.2.5 Anion separator column:

9.2.6 Anion analytical column: Dionex AS4A column (P/N 37041). An optional column may be used if comparable resolution of peaks is obtained.

9.2.7 Detector -- Conductivity cell: Approximately 1.25 µL internal volume, (Dionex, or equivalent) capable of providing data as required.

9.2.8 Volumetric pipettes and flasks

9.3 Analysis

9.3.1 Calibrate Monthly, or more frequently if needed, with a 3 point calibration.

Cal Standard #1

Working Solution Concentration	Volume of Working Solution	Final Volume in Distilled Water	Final Standard Concentration	Parameter
100 mg/L	0.250 mL	50 mL	0.5 mg/L	Fluoride
1000 mg/L	0.075 mL	50 mL	1.5 mg/L	Chloride
100 mg/L	0.125 mL	50 mL	0.25 mg/L	Nitrite
100 mg/L	0.50 mL	50 mL	1.0 mg/L	Bromide
100 mg/L	0.125 mL	50 mL	0.25 mg/L	Nitrate
100 mg/L	0.125 mL	50 mL	0.25 mg/L	Ortho-Phosphate
1000 mg/L	0.250 mL	50 mL	5.0 mg/L	Sulfate

Cal Standard #2

Working Solution Concentration	Volume of Working Solution	Final Volume in Distilled Water	Final Standard Concentration	Parameter
100 mg/L	0.50 mL	50 mL	1.0 mg/L	Fluoride
1000 mg/L	0.250 mL	50 mL	5.0 mg/L	Chloride
100 mg/L	0.50 mL	50 mL	1.0 mg/L	Nitrite
100 mg/L	1.5 mL	50 mL	3.0 mg/L	Bromide
100 mg/L	0.750 mL	50 mL	1.5 mg/L	Nitrate
100 mg/L	0.750 mL	50 mL	1.5 mg/L	Ortho-Phosphate
1000 mg/L	0.750 mL	50 mL	15.0 mg/L	Sulfate

Cal Standard #3

Working Solution Concentration	Volume of Working Solution	Final Volume in Distilled Water	Final Standard Concentration	Parameter
100 mg/L	1.0 mL	50 mL	2.0 mg/L	Fluoride
1000 mg/L	0.4 mL	50 mL	8.0 mg/L	Chloride
100 mg/L	1.0 mL	50 mL	2.0 mg/L	Nitrite
100 mg/L	3.0 mL	50 mL	6.0 mg/L	Bromide
100 mg/L	1.5 mL	50 mL	3.0 mg/L	Nitrate
100 mg/L	1.5 mL	50 mL	3.0 mg/L	Ortho-Phosphate
1000 mg/L	1.75 mL	50 mL	35 mg/L	Sulfate

9.3.2 Load and inject a fixed amount of well mixed sample.

9.3.3 Flush injection loop thoroughly, using each new sample. Use the same size loop for standards and samples.

9.3.4 Record the resulting peak size in peak height units.

9.3.5 The width of the retention time window used to make identifications should be based upon measurements of actual retention time variations of standards over the course of a day. Three times the standard deviation of a retention time can be used to calculate a suggested window size for each analyte. However, the experience of the analyst should weigh heavily in the interpretation of chromatograms.

9.3.6 If the response for the peak exceeds the working range of the system, dilute the sample with an appropriate amount of reagent water and reanalyze.

Note: Retention time is inversely proportional to concentration. Nitrate and sulfate exhibit the greatest amount of change, although all anions are affected to some degree. In some cases this peak migration may produce poor resolution or identification.

9.3.7 The following extraction should be used for solid materials.
  9.3.7.1 Add an amount of reagent water equal to 20 times the weight of dry solid material taken as a sample.

9.3.8 It has been reported that lower detection limits for bromate (>7 µg/L) can be obtained using a borate based eluent . The use of this eluent or other eluents that improve method performance may be considered as a minor modification of the method and as such still are acceptable.

9.3.9 Should more complete resolution be needed between peaks the eluent can be diluted.
  9.3.9.1 This will spread out the run but will also cause the later eluting anions to be retained longer. The analyst must determine to what extent the eluent is diluted. This dilution should not be considered a deviation from the method.

9.4 Data Analysis and Calculation

9.4.1 The data station calculates the concentration of the samples by comparing sample peak response to that of the standards.

9.4.2 Multiply answer by appropriate dilution factor.

9.4.3 Report only those values that fall between the lowest and the highest calibration standards.

9.4.4 Samples exceeding the highest standard should be diluted and reanalyzed.

9.4.5 Report results in mg/L.

10.0 QUALITY CONTROL

SAMPLE TYPE	FREQUENCY	QC LIMIT	CORRECTIVE ACTION
Initial Calibration	As needed, no more than 1 month.	% Difference <10%	Halt analysis re-calibrate. If still out re-make standards and re-calibrate.
Continuing Calibration Blank (CCB)	One per every 10 samples.	< Detection Limit	Reanalyze, if still out, clean system and begin analysis over at last passing CCB.
Continuing Calibration Blank (CCV)	One per every 10 samples.	90-110%	Reanalyze, if still out recalibrate and reanalyze all samples not bracketed by passing CCV.
Duplicate	One per matrix, or per analytical batch.	< 20% RPD	Reanalyze, if precision criteria still not met determine if matrix or method is the cause.

Matrix Spike (MS)	One per analytical batch preferably on a sample with a positive result.	F - 80-120% NO_2 80-120% Br - 80-120% Cl -80-120% NO_3 - 80-120% SO_4 - 80-120% O-PO_4 80-120%	If ms recovery is out re-analyze sample. If still out and LCS is within control limits, assume matrix interference.
Laboratory Control Sample (LCS)	One per matrix or per analytical batch.	F - 90-110% NO_2 90-110% Br - 90-110% Cl - 90-110% NO_3 - 90-110% SO_4 - 90-110% O-PO_4 90-110%	Re-analyze. If still out, halt analysis, re-calibrate and re-analyze associated samples.
MDL Study Prepare 7 standards at a concentration that is equivalent to the reporting limit.	Yearly	The concentration of the calculated MDL must be greater than 1/10 of the prepared standard concentration	See QA Manager
Initial Demonstration of Capability: prepare and analyze 4 blank spikes or 4 LCS's	For each new analyst before unsupervised analysis of samples	90-110%	Prepare and reanalyze new samples. If still out see QA Manager.

11.0 DEFINITIONS

Analytical Batch - shall be defined as environmental samples that are analyzed together with the same method and personnel, using the same lots of reagents, not to exceed the analysis of 20 environmental samples.

Calibration Blank - A volume of reagent water acidified with the same acid matrix as in the calibration standards. The calibration blank is a zero standard and is used to calibrate the ICP instrument.

Calibration Standard (CAL) - A solution prepared from the dilution of stock standard solutions. The CAL solutions are used to calibrate the instrument response with respect to analyte concentration.

Continuing Calibration Verification (CCV) solution or Instrument Performance Check (IPC) Solution – standard used to determine the state of calibration of an instrument between periodic recalibrations.

Daily Performance Check Solution - A solution of method analytes, used to evaluate the performance of the instrument system with respect to a defined set of method criteria.

Dissolved Analyte - The concentration of analyte in an aqueous sample that will pass through a 0.45 µm membrane filter assembly prior to sample acidification.

Field Blank (FB) - An aliquot of reagent water or other blank matrix that is placed in a sample container in the laboratory and treated as a sample in all respects, including shipment to the sampling site, exposure to the sampling site conditions, storage, preservation, and all analytical procedures. The purpose of the FB is to determine if method analytes or other interferences are present in the field environment.

Initial Calibration Verification (ICV) solution - A solution prepared from the dilution of stock standard solutions different from the source of calibration standards. Used to check the calibration. The ICV is also known as the QCS (Quality Control Sample).

Laboratory Control Standard (LCS) or Laboratory Fortified Blank (LFB) - An aliquot of reagent water to which known quantities of the method analytes are added in the laboratory. The LCS is analyzed exactly like a sample, and its purpose is to determine whether the methodology is in control and whether the laboratory is capable of making accurate and precise measurements. Note: the matrix spike (MS) may be used in place of this control as long as the acceptance critera are as stringent as for the LCS.

Laboratory Control Standard Duplicate (LCSD) – A second aliquot of reagent water to which known quantities of the method analytes are added in the laboratory and analyzed separately with identical procedures. Analyses of the LCS and LCSD indicates precision associated with laboratory procedures, but not with sample collection, preservation, or storage procedures.

Linear Range (LR) or Linear Dynamic Range (LDR) - The concentration range over which the instrument response to an analyte is linear.

Limit of Quantitation (LOQ): The lowest concentration that can be reliably achieved within specified limits of precision and accuracy during routine laboratory operating conditions. For many analytes the LOQ analyte concentration is selected as the lowest non-zero standard in the calibration curve.

Matrix Duplicate (MD) or Duplicate (DU) – A second aliquot of the same sample taken in the laboratory and analyzed separately with identical procedures. Analyses of the sample and MD indicates precision associated with laboratory procedures, but not with sample collection, preservation, or storage procedures.

Matrix Spike (MS) or Laboratory Fortified Matrix (LFM) - An aliquot of an environmental sample to which known quantities of the method analytes are added in the laboratory. The MS is analyzed exactly like a sample, and its purpose is to determine whether the sample matrix contributes bias to the analytical results. The background concentrations of the analytes in the sample matrix must be determined in a separate aliquot and the measured values in the MS corrected for background concentrations.

Matrix Spike Duplicate (MSD) - A second aliquot of the same sample to which known quantities of the method analytes are added in the laboratory and analyzed separately with identical procedures. Analyses of the MS and MSD indicates precision associated with laboratory procedures, but not with sample collection, preservation, or storage procedures.

Method Blank (MB) or Laboratory Reagent Blank (LRB)- An aliquot of reagent water or other blank matrices that are treated exactly as a sample including exposure to all glassware, equipment, solvents, reagents, and internal standards that are used with other samples. The MB is used to determine if method analytes or other interferences are present in the laboratory environment, reagents, or apparatus.

Method Detection Limit (MDL) - The minimum concentration of an analyte confirmed by qualitative identification of the analyte(s) in a QC sample in each quality system matrix containing the analyte at no more than 2-3X the MDL for a single analyte tests and 1-4X the MDL for multiple analyte tests that can be identified, measured, and reported with 99% confidence that the analyte concentration is greater than zero but less than the reporting limit (RL). See method SOP for further qualifications.

Non-conformance Memo (NCM): Memo of an indication, judgment, or state of not having met the requirements of the relevant specifications, contract, or regulation.

Solid Sample - For the purpose of this method, a sample taken from material classified as either soil, sediment or sludge.

Stock Standard Solution - A concentrated solution containing one or more method analytes prepared in the laboratory using assayed reference materials or purchased from a reputable commercial source.

Water Sample - For the purpose of this method, a sample taken from one of the following sources: drinking, surface, ground, storm runoff, industrial or domestic wastewater.

TECHNICAL OPERATING PROCEDURE

1.0 PROCEDURE TITLE: Ferrous Iron SM19 3500-Fe-D

Approvals and Signatures

Laboratory Director: Renée Cusack Date: 1/4/11
QA Manager: Maria A. Pötsch Date: 1/4/11
Section Supervisor: Renée Cusack Date: 1/4/11
EH&S Officer: Lisa Savage Date: 1/5/11
Control#: 136

2.0 AREA OF APPLICABILITY: Wet Chemistry

3.0 SCOPE: This method is applicable to the measurement of ferrous iron in natural and treated water.

4.0 PRINCIPLE: Iron is brought into solution, reduced to the ferrous state with acid and hydroxylamine and treated with 1,10-phenanthroline at pH 3.2-3.3. Phenanthroline chelates each atom of ferrous iron to form an orange-red complex.

5.0 REFERENCES

5.1 "Standard Methods for the Examination of Water and Wastewater", 19th edition, 1995, pp 3-68 – 3-70.

6.0 PRESERVATION AND HOLD TIME

6.1 Analyzed immediately. There may be a change in the ratio of ferric to ferrous iron if samples are not analyzed at the sampling site. Preserve samples by adding 2ml conc. HCL for every 100 ml sample.

7.0 INTERFERENCES

7.1 Strong oxidizing agents, cyanide, nitrite, phosphates, chromium, zinc in concentration exceeding 10x that of iron, cobalt and copper in excess if 5mg/l and nickel in excess of 2mg/l.

7.2 Bismuth, cadmium, mercury, molybdate and silver precipitate phenanthroline.

7.3 In the presence of interfering metal ions, use a larger excess of phenanthroline to replace that complexed by the interfering metal ions.

8.0 APPLICABLE /ASSOCIATED SOPS

8.1 SAFETY: Employees must abide by the policies and procedures in the Corporate Safety Manual, Radiation Safety Manual and this document.

8.1.1 SPECIFIC SAFETY CONCERNS OR REQUIREMENTS

8.1.1.1 Samples that contain high concentrations of carbonates or organic material or samples that are at elevated pH can react violently when acids are added.

8.1.2 PRIMARY MATERIALS USED

8.1.2.1 The following is a list of the materials used in this method, which have a serious or significant hazard rating. NOTE: This list does not include all materials used in the method. The table contains a summary of the primary hazards listed in the MSDS for each of the materials listed in the table. A complete list of materials used in the method can be found in the reagents and materials section. Employees must review the information in the MSDS for each material before using it for the first time or when there are major changes to the MSDS.

Material (1)	Hazards	Exposure Limit (2)	Signs and symptoms of exposure
Hydrochloric Acid	Corrosive Poison	5 ppm-	Inhalation of vapors can cause coughing, choking, inflammation of the nose, throat, and upper respiratory tract, and in severe cases, pulmonary edema, circulatory failure, and death. Can cause redness, pain, and severe skin burns. Vapors are irritating and may cause damage to the eyes. Contact may cause severe burns and permanent eye damage.
Hydroxylamine Hydrochloride	Corrosive Poison	None	Extremely destructive to tissues of the mucous membranes and upper respiratory tract. Corrosive to the eyes. Irritant and possible sensitizer. May cause burns to the skin.
1 – Always add acid to water to prevent violent reactions.			
2 – Exposure limit refers to the OSHA regulatory exposure limit.			

8.2 WASTE MANAGEMENT AND POLLUTION PREVENTION

8.2.1 All waste will be disposed of in accordance with Federal, State and Local regulations. Where reasonably feasible, technological changes have been implemented to minimize the potential for pollution of the environment. Employees will abide by this method and the policies in section 13 of the Corporate Safety Manual for "Waste Management and Pollution Prevention."

- 8.2.1.1 Waste Streams Produced by the Method
  - 8.2.1.1.1 The following waste streams are produced when this method is carried out.
    - 8.2.1.1.1.1 Acidic waste generated by the analysis must be discarded down the acid neutralizing sink.

9.0 PROCEDURE

9.1 Reagents

- 9.1.1 Use reagents low in iron.
- 9.1.2 Store reagents in glass-stoppered bottles.
- 9.1.3 The standard iron solutions are not stable and must be prepared every time the analysis is performed.
- 9.1.4 Hydrochloric Acid (HCL): concentrated
  - 9.1.4.1 Mallinckrodt or equivalent
- 9.1.5 Ammonium acetate buffer solution
  - 9.1.5.1 Dissolve 250g ammonium acetate in 150ml water.
  - 9.1.5.2 Add 700ml glacial acetic acid.
  - 9.1.5.3 Stable indefinitely if tightly stoppered.
- 9.1.6 Phenanthroline Solution
  - 9.1.6.1 Dissolve 100mg 1,10-phenanthroline monohydrate in 100ml deionized water.
  - 9.1.6.2 Add 2 drops HCl to dissolve.
- 9.1.7 Stock Iron Solution (1000mg/l)
  - 9.1.7.1 Purchased from Ricca or equivalent
- 9.1.8 Iron Standard Solution
  - 9.1.8.1 Pipet 1ml stock iron solution(1000 ug/ml) and dilute to 100ml in a volumetric flask with deionized H20. Conc=1ml=10ug
- 9.1.9 Hydroxylamine Hydrochloride
  - 9.1.9.1 Dissolve 120g sodium chloride and 120g hydroxylamine hydrochloride in 1 liter deionized water.

9.2 Apparatus

- 9.2.1 Spectrophotometer
  - 9.2.1.1 For use at 510nm, providing a light path of 1 cm or longer.
- 9.2.2 Standard laboratory acid washed glassware
  - 9.2.2.1 Wash all glassware with concentrated hydrochloric acid and rinse with distilled water before use to remove deposits of iron oxide.
  - 9.2.2.2 125ml erlenmeyer flask
  - 9.2.2.3 volumetric flasks

9.3 Analysis

- 9.3.1 Mix the sample and measure 25ml into 250ml erlenmeyer flask.
- 9.3.2 Add 10ml phenanthroline
- 9.3.3 Add 5ml ammonium acetate solution
- 9.3.4 Add 0.5ml hydroxlyamine hydrochloride
- 9.3.5 Dilute to 50ml with deionized water
- 9.3.6 Mix thoroughly and allow at least 5-10 minutes for maximum color development.
- 9.3.7 Standard Curve
  - 9.3.7.1 Prepare whenever new color reagents are made.
  - 9.3.7.2 Prepare standard solutions at 10, 20, 40 and 50 ug/ml by adding 1, 2, 4 and 5ml of the intermediate solution into a 250ml volumetric and treat the standard solutions like the samples.
  - 9.3.7.3 Follow steps 9.3.2 to 9.3.4 and 9.3.6.
- 9.3.8 Read standards against distilled water set at zero absorbance at 510nm in a large cell and plot a calibration curve including a blank.

9.4 Calculation

- 9.4.1 Use the formula:

$$\text{mg Fe/l} = \frac{\text{ug Fe (in 25ml final volume)}}{\text{ml sample}}$$

9.5 Quality Control

- 9.5.1 Duplicate precision
  - 9.5.1.1 One per batch or one for every 10 samples, whichever is more frequent.
- 9.5.2 Analytical Spike Recovery
  - 9.5.2.1 One per batch or one for every 10 samples, whichever is more frequent.

QC ANALYSIS	FREQUENCY	QC CRITERIA	CORRECTIVE ACTION
Initial Demonstration of Capability: prepare and analyze 4 blank spikes or 4 ICV/LCS	For each new analyst	86-108% % RSD must be less than 10%	Prepare and reanalyze new samples. If still out see QA Manager.
Initial Calibration	Every three months or when new stock standards/reagents are made	R≥ 0.995	Re-analyze standards; if still problematic, check stock standards and reagents

QC ANALYSIS	FREQUENCY	QC CRITERIA	CORRECTIVE ACTION
Initial Calibration Verification (ICV/LCS)	Analyze immediately following calibration. One per analytical sequence	Lab Limits: 86-108%	Re-analyze one time, if still falls outside the control limit the analysis must be terminated, the cause determined and a new curve must be analyzed.
Initial Calibration Blank (ICB)	Analyze immediately after ICV. One per analytical sequence.	< Reporting Level	Re-analyze one time, if the ICB still contains concentrations > Reporting Level, the analysis must be terminated, the cause determined (Check glassware & reagents). Re-analyze ICB.
Continuing Calibration Verification (CCV)	Every 10 samples	Lab Limits: 86-108%	If the percent recovery falls outside the acceptable limits the CCV must be re-analyzed.
Continuing Calibration Blank (CCB)	Every 10 samples	< ½ RL	Re-analyze one time, if the CCB still contains concentrations > ½ Reporting Level, the analysis must be terminated, the cause determined and the CCB re-analyzed.
Matrix Spike (MS)	One per Analytical Batch of 10 samples or less.	Lab Limits: 62-163%	If the matrix spike recovery falls outside the acceptable limits prepare another matrix spike sample at a 4 time dilution & re-analyze. If spike still fails report data with a flag and NCM.
Duplicate (MD/DU)	One per Analytical Batch of 10 samples or less.	Lab Limits RPD <20%	Report data with duplicate flagged.

10.0
DEFINITIONS (STANDARD METHODS 4000)

Analytical Batch - shall be defined as environmental samples that are analyzed together with the same method and personnel, using the same lots of reagents, not to exceed the analysis of 20 environmental samples.
Calibration Blank - A volume of reagent water acidified with the same acid matrix as in the calibration standards. The calibration blank is a zero standard and is used to calibrate the instrument.

Calibration Standard (CAL) - A solution prepared from the dilution of stock standard solutions. The CAL solutions are used to calibrate the instrument response with respect to analyte concentration.
Continuing Calibration Verification (CCV) solution – standard used to determine the state of calibration of an instrument run after every 10 sample must be within 10% of target value.
Continuing Calibration Blank (CCB)- A volume of reagent water acidified with the same acid matrix as in the calibration standards. The calibration blank is a zero standard and is run after every 10 samples following the CCV it must be less than ½ the RL.
Initial Calibration Verification (ICV) solution - A solution prepared from the dilution of stock standard solutions different from the source of calibration standards. Used to check the calibration. If the recovery is not set in the method it is to be calculated using Standard Method Section 1020B.12.
Laboratory Control Standard (LCS) - An aliquot of reagent water to which known quantities of the method analytes are added in the laboratory. The LCS is analyzed exactly like a sample, and its purpose is to determine whether the methodology is in control and whether the laboratory is capable of making accurate and precise measurements. The LCS must be run with each batch of 20 samples. If the recovery is not set in the method it is to be calculated using Standard Method Section 1020B.12 to which known quantities of the method analytes are added in the laboratory and analyzed separately with identical procedures. Analyses of the LCS and LCSD indicates precision associated with laboratory procedures, but not with sample collection, preservation, or storage procedures.
Limit of Detection (LOD): The minimum amount of substance that an analytical process can reliably detect.
Limit of Quantitation (LOQ): The lowest concentration that can be reliably achieved within specified limits of precision and accuracy during routine laboratory operating
Matrix Duplicate (MD) or Duplicate (DU) – A second aliquot of the same sample taken in the laboratory and analyzed separately with identical procedures. Analyses of the sample and MD indicates precision associated with laboratory procedures, but not with sample collection, preservation, or storage procedures. If the RPD is not set in the method it is to be calculated using Standard Method Section 1020B.12.
Matrix Spike (MS) - An aliquot of an environmental sample to which known quantities of the method analytes are added in the laboratory. The MS is analyzed exactly like a sample, and its purpose is to determine whether the sample matrix contributes bias to the analytical results. The background concentrations of the analytes in the sample matrix must be determined in a separate aliquot and the measured values in the MS corrected for background concentrations. If the recovery is not set in the method it is to be calculated using Standard Method Section 1020B.12.
Matrix Spike Duplicate (MSD) - A second aliquot of the same sample to which known quantities of the method analyte are added in the laboratory and analyzed separately with identical procedures. Analysis of the MS and MSD indicates precision associated with

laboratory procedures, but not with sample collection, preservation, or storage procedures. If the RPD is not set in the method it is to be calculated using Standard Method Section 1020B.12.

Method Blank (MB) - An aliquot of reagent water or other blank matrices that are treated exactly as a sample including exposure to all glassware, equipment, solvents, reagents, and internal standards that are used with other samples. The MB is used to determine if method analytes or other interferences are present in the laboratory environment, reagents, or apparatus. The MB must not be more than ½ the RL. confirmed by qualitative identification of the analyte(s) in a QC sample in each quality system matrix containing the analyte at no more than 2-3X the MDL for a single analyte tests and 1-4X the MDL for multiple analyte tests that can be identified, measured, and reported with 99% confidence that the analyte concentration is greater than zero but less than the reporting limit (RL). See method SOP for further qualifications.

Method of Standard Addition (MSA) - The addition of a known amount of analyte to the sample in order to determine the relative response of the detector to an analyte within the sample matrix. The relative response is then used to assess either an operative matrix effect or the sample analyte concentration.

Quality Control Sample (QCS) - A solution of method analytes of known concentrations which is used to fortify an aliquot of MB or sample matrix. The QCS is obtained from a source external to the laboratory and different from the source of calibration standards. It is used to check either laboratory or instrument performance. If the recovery is not set in the method it is to be calculated using Standard Method Section 1020B.12.

Solid Sample - For the purpose of this method, a sample taken from material classified as either soil, sediment or sludge.

Stock Standard Solution - A concentrated solution containing one or more method analytes prepared in the laboratory using assayed reference materials or purchased from a reputable commercial source.

Water Sample - For the purpose of this method, a sample taken from one of the following sources: drinking, surface, ground, storm runoff, industrial or domestic wastewater.

STANDARD OPERATING PROCEDURE

1.0 PROCEDURE TITLE: pH

Approvals and Signatures

Laboratory Director: Renee Cusack Date: 1/20/12

Section Supervisor: Maria Date: 1/23/12

QA Manager: Maria Date: 1/23/12

EH&S Officer: Lisa M. Savage Date: 1/30/12

Control #: 162

2.0 AREA OF APPLICABILITY: Inorganic Chemistry

3.0 SCOPE: This method is applicable to drinking, surface, and saline waters, domestic and industrial wastes.

4.0 PRINCIPLE: The pH of a sample is determined electrometrically using either a glass electrode in combination with a reference potential or a combination electrode.

5.0 REFERENCES

5.1 "Standard Methods for the Examination of Water and Wastewater", 19th Edition, 1995, pp. 4-65, SM184500-HB.

6.0 PRESERVATION AND HOLD TIME: Samples can be collected in plastic or glass. Samples do not require any preservation and must be analyzed immediately.

7.0 INTERFERENCES

7.1 Sodium interferes with the determination of pH at pH levels greater than 10.

7.2 Temperature effects pH by changing the electrode output, this is automatically corrected by pH meter.

8.0 APPLICABLE/ASSOCIATED SOPS

8.1 Safety

8.1.1 Employees must abide by the policies and procedures in the Corporate Safety Manual and this document.

8.2 Waste Management and Pollution Prevention

8.2.1 All waste will be disposed of in accordance with Federal, State and Local regulations. Where reasonably feasible, technological changes have been implemented to minimize the potential for pollution of the environment. Employees will abide by this method and the policies in section 13 of the Corporate Safety Manual for "Waste Management and Pollution Prevention."

9.0 PROCEDURE

9.1 Reagents

9.1.1 Standard Buffers, at pH 4, pH 7, and pH 10

9.2 Apparatus

9.2.1 pH meter equipped with a combination electrode.

9.3 Analysis Calibration as per manufacturer's instructions

9.3.3 Rinse and blot dry the electrode between each reading.

9.4 Sample Analysis

9.4.1 Immerse the electrodes into the sample beaker and read pH.
9.4.2 Rinse and blot dry the electrode between each reading.
9.4.3 Store electrodes in the pH 7 buffer solution or according to manufactures specifications when not in use.

9.5 Calculation

9.5.1 Report pH to the nearest 0.01 unit.

10.0 QC Criteria

QC ANALYSIS	FREQUENCY	QC CRITERIA	CORRECTIVE ACTION
Buffer solution pH 7	Each calibration + prior to use.	+ / - 0.05 pH units	Re- calibrate meter.
Duplicate	Each time the analysis is performed or every 20 samples.	RPD < 5.0%	If matrix problem is encountered analyze an additional sample duplicate of another sample in the batch.

11.0 Definitions

11.1 An **Analytical batch** shall be defined as environmental samples that are analyzed together with the same method and personnel, using the same lots of reagents, not to exceed the analysis of 20 environmental samples.

11.2 The **Matrix Duplicate or MD is a** duplicate aliquot of a sample processed and analyzed independently; under the same laboratory conditions; also referred to as Sample Duplicate.

STANDARD OPERATING PROCEDURE

1.0 PROCEDURE TITLE: Turbidity, SM 2130B, EPA 180.1

Approvals and Signatures

Laboratory Manager: Renée Cusack Date: 11/29/11

QA Specialist: Maria Date: 12/1/11

Section Supervisor: Maria Date: 12/1/11

EHS Coordinator: Lisa M. Savage Date: 12/2/11

Control #: 43

2.0 AREA OF APPLICABILITY: Inorganic Chemistry

3.0 SCOPE: The method is applicable to drinking, surface, and saline waters in the range of turbidity from 0 to 40 nephelometric turbidity units (NTU).

4.0 PRINCIPLE: Turbidity in water is caused by suspended and colloidal matter. Turbidity is an expression of the optical property that causes light to be scattered and absorbed rather than transmitted with no change in direction or flux level through the sample. This method is based on a comparison of the intensity of light scattered by the sample under defined conditions with the intensity of light scattered by a standard reference suspension under the same conditions.

5.0 REFERENCES:

5.1 "Standard Methods for the Examination of Water and Wastewater", 21st Edition, 2005, p. 2-9, Method SM-2130B.

6.0 PRESERVATION AND HOLD TIME:

6.1 Preservation of the sample is not practical; analysis should begin as soon as possible. Refrigeration or icing to 4 C, to minimize microbiological decomposition of solids, is recommended. Samples must be analyzed within 48 hours.

7.0 INTERFERENCES:

7.1 The water sample must be free of debris and rapidly settling coarse sediments. Dirty glassware, condensation, the presence of air bubbles, and the effects of vibrations that disturb the surface visibility of the sample will give false results. "True color," i.e., water color due to dissolved substances that absorb light, causes measured turbidities to be low, this effect is usually not significant in treated water.

8.0 APPLICABLE/ASSOCIATED SOP'S

8.1 Safety:

- 8.1.1 Employees must abide by the policies and procedures in the Corporate Safety Manual, Radiation Safety Manual and this document.
- 8.1.2 Primary Materials Used
  - 8.1.2.1 There are no materials used in this method that have a serious or significant hazard rating. NOTE: This list does not include all materials used in the method. A complete list of materials used in the method can be found in the reagents and materials section. Employees must review the information in the MSDS for each material before using it for the first time or when there are major changes to the MSDS.

8.2 Waste Management and Pollution Prevention

- 8.2.1 All waste will be disposed of in accordance with Federal, State and Local regulations. Where reasonably feasible, technological changes have been implemented to minimize the potential for pollution of the environment. Employees will abide by this method and the policies in section 13 of the Corporate Safety Manual for "Waste Management and Pollution Prevention."
- 8.2.2 Waste Streams Produced by the Method
  - 8.2.2.1 The following waste streams are produced when this method is carried out.
  - 8.2.2.2 Acidic sample waste generated by the analysis is dumped down the acid neutralizing sink.
  - 8.2.2.3 Contaminated disposable glass or plastic materials utilized in the analysis is dumped in the glass disposal garbage.

9.0 PROCEDURE:

9.1 Reagents

9.1.1 Turbidity-free water

9.1.1.1 Use in house DI water.

9.1.2 Stock Turbidity Suspension

9.1.2.1 Commercially prepared Formazin standard (4000NTU) from HACH or equivalent.

9.1.3.Commercially prepared Turbidity working solution at 20 NTU (ICV).

9.1.4 LCS, Purchased from NSI or equivalent.

9.2 Apparatus

9.2.1 Turbidimeter with a nephelometer, Hach model 2100N and 2100A.

9.2.2 Sample tubes, clear colorless glass.

9.3 Analysis

9.3.1 Calibrate the turbidimeter following the manufacturers operating instructions.

9.3.2 Gently agitate sample.

9.3.3 Wait until air bubbles disappear and pour sample into turbidimeter tube.

9.3.4 Read turbidity directly from instrument scale.

9.4 Calulation:

9.4.1 Calculate turbidity:

$$NTU = \frac{Ax(B+C)}{C}$$

Where:

A=NTU found in diluted sample
B= volume of dilution water, ml
C= sample volume taken for dilution, ml

9.5 Quality Control

SAMPLE TYPE	FREQUENCY	QC LIMIT	CORRECTIVE ACTION
Sample Blank (ICB)	Prior to each analysis	<1.0 NTU	See supervisor
ICV	Prior to each analysis	80-115%	Discontinue analysis and determine problem, recalibrate if necessary.
LCS	Prior to each analysis	78-122%	Reprep and reanalyze. If still out discontinue analysis, determine problem and recalibrate if necessary.
MD	One every analytical batch	No Limit	N/A
Initial Demonstration of Capability (IDOC) MUST BE PREFORMED BEFORE SAMPLES CAN BE ANALYZED	At least 4 aliquots of LCS shall be prepared and analyzed as per method either concurrently or over a period of days. This must be done for all new personnel and at any time there is a change in instrumentation or method.	Mean recovery 85-115% Standard Deviation < 10.0%	Locate and correct the source of the problem and reanalyze. If still problematic inform QA manager.
Continued Demonstration of Capability	Must be preformed annually, by above IDOC method. Alternatively a successful PT result may be substituted.	Mean recovery 85-115% Standard Deviation < 10.0%	Locate and correct the source of the problem and reanalyze. If still problematic inform QA manager.

10.0 DEFINITIONS

10.1 An **Analytical batch** shall be defined as environmental samples that are analyzed together with the same method and personnel, using the same lots of reagents, not to exceed the analysis of 20 environmental samples.

10.2 **Continued Demonstration of Capability or CDOC** must be preformed annually to show an analysts continued proficiency performing the test method. It shall consist of a quality control sample that is obtained from and outside source. The standard should be 1-4X the LOQ and at least four aliquots shall be prepared and analyzed according to the test method either concurrently or over a period of days. The resulting data shall be evaluated by the QA manager or section supervisor to determine if it meets acceptance criteria. Also, a passing PT sample can be substituted.

10.3 **Initial Demonstration of Capability of IDOC** must be made prior to using any test method, and at any time there is a change in instrument type, personnel or test method. It shall consist of a quality control sample that is obtained from and outside source. The standard should be 1-4X the LOQ and at least four aliquots shall be prepared and analyzed according to the test method either concurrently or over a period of days. The resulting data shall be evaluated by the QA manager or section supervisor to determine if it meets acceptance criteria.

10.4 **Initial Calibration Verification or ICV** is a standard used to determine the state of calibration of an instrument between periodic recalibrations. It is run before any samples are run to insure the method is in control.

10.5 **LCS or Laboratory Control Standard** is a standard, usually certified by and outside agency, used to measure the bias in a procedure. It is used to evaluate the performance of the total analytical system, including all preparation and analysis steps. Results of the LCS are compared to established criteria and, if found to be outside these criteria, indicates that the analytical system is "out of control". Any affected samples associated with an out of control LCS shall be reprocessed for re-analysis or the results reported with appropriate data qualifying codes. An LCS shall be analyzed at a minimum of 1 per analytical batch. The LCS is a quality system matrix, known to be free of analytes of interest, spiked with known and verified concentrations of analytes.

10.6 The **Matrix Duplicate or MD is a** duplicate aliquot of a sample processed and analyzed independently; under the same laboratory conditions; also referred to as Sample Duplicate.

10.7 The **Method Blank or MB** is used to assess the preparation batch for possible contamination during the preparation and processing steps. The method blank shall be processed along with and under the same conditions as the associated samples to include all steps of the analytical procedure. Procedures shall be in place to determine if a method blank is contaminated. Any affected samples associated with a contaminated method blank shall be reprocessed for analysis or the results reported with appropriate data qualifying codes.

STANDARD OPERATING PROCEDURE

1.0 PROCEDURE TITLE: Total Organic Carbon, Dissolved Organic Carbon, Total Inorganic Carbon (Persulfate-Ultraviolet Oxidation Method)

Approvals and Signatures

Laboratory Manager: Renee Cusack Date: 5/10/12

QA Manager: Date: 5/9/12

Section Supervisor: Date: 5/9/12

EHS Coordinator: Date: 5/10/12

Control #: 140

2.0 AREA OF APPLICABILITY: Inorganics

3.0 SCOPE: The method is applicable to the measurement of organic carbon in drinking, surface, and saline waters, domestic and industrial wastes.

4.0 PRINCIPLE:

Organic carbon in a sample is converted to carbon dioxide (CO2) by catalytic combustion or wet chemical oxidation. The CO_2 formed can be measured directly by an infrared detector or converted to methane (CH_4) and measured by a flame ionization detector. The amount of CO_2 or CH_4 is directly proportional to the concentration of carbonaceous material in the sample.

5.0 REFERENCES

5.1 "Methods for Chemical Analysis of Water and Wastes", EPA 821-C-99-004, June 1999, Method 415.2

5.2 "Standard Methods for The Examination of Water and Wastewater", 21st Edition, 2005, p. 5-23, Method SM 5310 C.

5.3 Model 1010 Wet Oxidation Total Organic Carbon Analyzer Operator's Manual, OI Analytical, Rev. 9.4, April 2003.

6.0 PRESERVATION AND HOLD TIME:

6.1 Samples are collected in 40mL glass vials with TFE-backed septa preserved with H2SO4 to a pH ≤2. Acid preservation, however, invalidates any inorganic carbon determination on samples. The samples must be stored at 4°C and analyzed within 28 days.

7.0 INTERFERENCES:

7.1 Removal of carbonate and bicarbonate by the acidification and purging with purified gas results in the loss of volatile organic substances. The volatiles also can be lost during sample blending, particularly if the temperature is allowed to rise. Another important loss can occur if large carbon-containing particles fail to enter the needle used for injection. Any contact with organic material may contaminate a sample. Avoid contaminated glassware, plastic containers and rubber tubing.

7.2 The intensity of the ultraviolet light reaching the sample matrix may be reduced by highly turbid samples or with the aging of the ultraviolet source, can result in sluggish and incomplete oxidation of organic carbon.

7.3 Insufficient acidification will result in incomplete release of CO2.

7.4 Persulfate oxidation of organic molecules is slowed in samples containing significant concentrations of chloride by the preferential oxidation of chloride, at a concentration of 0.1% chloride, oxidation of organic matter may be inhibited completely. To remove this interference, add mercuric nitrate to the persulfate solution.

7.5 Filtration, although necessary to eliminate particulate organic matter when only DOC is to be determined, can result in loss or gain of DOC, depending on the physical properties of the carbon-containing compounds and the adsorption from it. Check filters for their contribution to DOC by analyzing a filtered blank.

7.6 Note that any contact with organic material may contaminate a sample.

8.0 APPLICABLE/ASSOCIATED SOPS

8.1 SAFETY

8.1.1 Employees must abide by the policies and procedures in the Corporate Safety Manual and this document.

8.1.2 SPECIFIC SAFETY CONCERNS OR REQUIREMENTS

8.1.2.1 The auto sampler has a probe that is sharp; use caution not to stick yourself.

8.1.2.2 The furnace is very hot and can cause severe burns if touched.

8.1.2.3 The Sodium Persulfate is a <u>strong oxidizer</u>. Avoid contact with combustible materials, organic materials, strong reducing agents, and excess heat.

8.1.3 PRIMARY MATERIALS USED

8.1.3.1 The following is a list of the materials used in this method, which have a serious or significant hazard rating. NOTE: This list does not include all materials used in the method. The table contains a summary of the primary hazards listed in the MSDS for each of the materials listed in the table. A complete list of materials used in the method can be found in the reagents and materials section. Employees must review the information in the MSDS for each material before using it for the first time or when there are major changes to the MSDS.

Material (1)	Hazards	Exposure Limit (2)	Signs and symptoms of exposure
Sulfuric Acid	Corrosive Oxidizer Dehydra-dator	1 mg/m^3	This material will cause burns if comes into contact with the skin or eyes. Inhalation of vapors will cause irritation of the nasal and respiratory system.
Phosphoric Acid	Corrosive	1 mg/m^3 TWA	Inhalation is not an expected hazard unless misted or heated to high temperatures. May cause redness, pain, and severe skin burns. May cause redness, pain, blurred vision, eye burns, and permanent eye damage.
Sodium Persulfate	Oxidizer Corrosive	0.1 mg/m^3-TWA as Persulfates	Causes irritation to the respiratory tract. Symptoms may include sore throat, shortness of breath, inflammation of nasal passages, coughing, and wheezing. Causes severe irritation or burns to the skin and eyes. Symptoms include redness, itching, pain and burns. May cause allergic skin reactions. Can cause eye damage.
1 – Always add acid to water to prevent violent reactions.			
2 – Exposure limit refers to the OSHA regulatory exposure limit.			

8.2 Waste Management and Pollution Prevention Section

8.2.1 All waste will be disposed of in accordance with Federal, State and Local regulations. Where reasonably feasible, technological changes have been implemented to minimize the potential for pollution of the environment. Employees will abide by this method and the policies in section 13 of the Corporate Safety Manual for "Waste Management and Pollution Prevention."

8.2.2 Waste Streams Produced by the Method

8.2.2.1 The following waste streams are produced when this method is carried out.

8.2.2.1.1 Acidic waste from the auto-analyzer is collected in a bottle and then discarded down the acid neutralizing sink in wet chem.

9.0 PROCEDURE

9.1 Reagents

9.1.1 De-ionized (DI) water with a TOC value of < 2X the MDL.

9.1.2 Organic carbon stock solution: Potassium Biphthalate (KHP) Stock Solution (1000mg/L)

9.1.2.1 Dissolve 1.064g of potassium KHP (previously dried to a constant mass at 110C) in DI water and dilute to 500.0mL.

9.1.3 KHP Standard, Continuing Calibration Verification Standard Solution (CCV) (10mg/L)

9.1.3.1 Dilute 2.5mL of 1000 mg/L stock KHP solution to 250mL with DI water.

9.1.4 KHP Standard at reporting level (CRA) 1mg/L

9.1.4.1 Dilute 5mL of the 10mg/L CCV standard to 50mL with DI water.

9.1.5 Prepare working standards by diluting the stock KHP solution (1000mg/L) into a series of standards that will encompass the expected concentration range of the samples. See below table for examples.

Stock Standard Concentration	Volume of Stock Standard Solution	Final Volume	Final Concentration Of Working Standard
1000 mg/L	0.1 mL	100 mL	1.0 mg/L
1000 mg/L	1.0 mL	100 mL	10.0 mg/L
1000 mg/L	5.0 mL	100 mL	50.0 mg/L
1000 mg/L	10.0 mL	100 mL	100.0 mg/L

9.1.6 Inorganic carbon stock solution (Na_2CO_3) 1000mg/L

9.1.6.1 Dissolve 4.413g of Na_2CO_3 (previously dried to a constant mass at 110C) in DI water to 500mL.

9.1.7 Inorganic carbon working standards. Prepare as above organic carbon working standards using the inorganic carbon stock solution.

9.1.8 Sodium Persulfate Solution:

9.1.8.1 Weigh 100.0g of Sodium persulfate to 1 liter with DI water.

9.1.9 Phosphoric Acid Solution:

9.1.9.1 Add 59mL of 85% Phosphoric Acid to DI water and dilute to a final volume of 1 liter with DI water.

9.1.10 LCS Solution

9.1.10.1 Dilute purchased TOC Demand Standard so that the concentration is in the range of 20 to 60 mg/L with DI water.

9.2 Apparatus:

9.2.1 OI Analytical TOC Analyzer Model 1010 or equivalent equipped with an auto sampler. Follow manufacturer's instructions for analyzer assembly, testing, calibration and operation.

9.3 Analysis:

9.3.1 Samples with particulate matter must be decanted prior to analysis to prevent clogging of the instrument with particulates.

9.3.2 If dissolved organic carbon is to be determined, filter sample and a reagent blank through an acid rinsed 0.45um glass fiber filter. Rinse filter with 1:1 HCL and reagent water before use. Use a clean acid rinsed flask for each sample. Filter enough of one sample for a duplicate and spike of that sample. Filter reagent water for a method blank and a prepared LCS solution (sec. 9.1.10).

9.3.3 Prior to analysis:
  - 9.3.3.1 Fill DI water level in rinse container
  - 9.3.3.2 Check the phosphoric acid and sodium persulfate levels
  - 9.3.3.3 Dump the old waste
  - 9.3.3.4 Check the gas pressure. It should be 55 psi at the Tank.
  - 9.3.3.5 Run a series of reagent blanks until TOC area counts are 300 or less.

9.3.4 Instrument Set Up
  - 9.3.4.1 Go to Databases, Sequence (for sample sequence)
  - 9.3.4.2 Start sequence with a reagent blank, LCS, MB, CCV, CCB and CRA. (a template is in the instrument software)
  - 9.3.4.3 Enter sample name in correct position number.
  - 9.3.4.4 Method-Default
  - 9.3.4.5 Type-Sample
  - 9.3.4.6 Reps-2 (Max of 5), repeat injections until consecutive measurements are obtained that are reproducible to within ± 10%.
  - 9.3.4.7 In a recalled sequence file, only the sample name will need to be typed.
  - 9.3.4.8 Save sequence (use 'save as' if you do not want to write over the recalled sequence).
  - 9.3.4.9 Click OK
  - 9.3.4.10 Enter a File Name
    - 9.3.4.10.1 Go to setup, WINTOC output
    - 9.3.4.10.2 Subdirectory: date (i.e.: 030210)
    - 9.3.4.10.3 Log File Name: same
    - 9.3.4.10.4 Prefix: same Counter: 01
    - 9.3.4.10.5 If you need to start the run over for any reason, give the file a new name (i.e.: 030210B)

9.3.5 Set up Samples and standards in auto sampler using 40 ml vials.

9.3.6 Prepare a duplicate sample and spike sample for every 20 TOC samples (and DOC if required).

9.3.7 The spike sample is prepared by adding 800µL of 1000mg/L stock solution to a final volume of 40mL using the sample to be spiked.

9.3.8 CCV/CCB are to be analyzed every 10 samples.

9.3.9 Click OK and the run is ready to start.

9.3.10 Once the Initial Calibration is analyzed, it can be recalled for subsequent runs. If the QC falls outside the acceptable limits, the initial calibration needs to be re-analyzed.

9.4 Calculation

9.4.1 The TOC results are directly read in mg/L.

10.0 QUALITY CONTROL

QC ANALYSIS	FREQUENCY	QC CRITERIA	CORRECTIVE ACTION
Method Detection Limit Study (MDL)	Prepare 7 spike samples at a concentration near the suspected reporting limit at method start-up and then 1 per year.	Calculate mean recovery and standard deviation.	The calculated MDL should be < the reporting limit but > 10% the concentration of the standard analyzed. If not, the MDL study needs to be performed at a lower concentration.
Initial Demonstration of Capability (IDOC): Prepare and analyze 4 blank spikes at a concentration 1-4 X the reporting limit	Each new analyst must analyze IDC prior to the unsupervised analysis of samples	80-120% ≤20% RSD	Repeat IDOC. If still out; see QA Manager.
Initial Calibration	As needed by results of ICV.	R≥ 0.995	Re-analyze standards; if still problematic, check stock standards and reagents
Initial Calibration Verification (ICV)/Laboratory Control Sample (LCS)	One pre Analytical batch.	Lab Limits 85-115%	Re-analyze; if still out prepare a new initial calibration curve.
Method Blank (MB)	One per Analytical Batch	< Reporting Limit (RL)	Re-analyze; if still out, clean glassware and begin analysis over
Matrix Spike (MS)	One per Analytical Batch, preferably on a sample with a positive result	Lab Limits 62-117%	If MS recovery indicates a suppressive interference the sample and MS should be diluted and re-analyzed. If the addition of the spike extends the concentration beyond the calibration curve, the sample should be diluted and the calculated results adjusted accordingly.
Duplicate (DU/MD)	One per matrix, or per Analytical Batch	Lab Limits % RPD < 20%	Re-analyze; if precision criteria still not met determine if matrix or method is cause
Continuing Calibration Verification (CCV)	Every 10 samples and as final standard	85-115%	Re-analyze another aliquot; if still out recalibrate and reanalyze all samples not bracketed by passing CCV.

Continuing Calibration Blank (CCB)	Every ten samples and as final Blank	< Reporting Limit	Re-analyze; if still out, clean glassware and begin analysis over at last passing CCB.
Standard @ Reporting Limit (CRA)	At beginning of run	No limits	None required at this time.

11.0 Definitions

Calibration Blank - The calibration blank is a zero standard and is used to calibrate the instrument.

Calibration Standard (CAL) - A solution prepared from the dilution of stock standard solutions. The CAL solutions are used to calibrate the instrument response with respect to analyte concentration.

Continued Calibration Verification (CCV) solution - A solution prepared from the dilution of stock standard solutions. Used to check the calibration.

Continued Calibration Blank (CCB) - The calibration blank is reagent water and is used to check the calibration.

CRA – Standard at reporting limit.

Laboratory Control Standard (LCS) - A solution prepared from the dilution of stock standard solutions different from the source of calibration standards. Used to check the calibration.

Method Blank (MB) - An aliquot of reagent water or other blank matrices that are treated exactly as a sample including exposure to all glassware, equipment, solvents and reagents that are used with other samples. The MB is used to determine if method analytes or other interferences are present in the laboratory environment, reagents, or apparatus.

TOC – Total Organic Carbon

DOC – Dissolved Organic Carbon – the fraction of TOC that passes through a 0.45 um filter

TIC – Total Inorganic Carbon

STANDARD OPERATING PROCEDURE

0.0 PROCEDURE TITLE: Total Dissolved Solids, SM 18-21 2540C

Approvals and Signatures

Laboratory Manager: Denise Cusack Date: 10/4/12

QA Manager: Date: 10/1/12

Section Supervisor: Date: 10/1/12

EH&S Officer: Date: 10/1/12

Control #: 22

1.0 AREA OF APPLICABILITY: Inorganic Chemistry

2.0 SCOPE: The method is applicable to drinking, surface, and saline waters, domestic and industrial wastes.

3.0 PRINCIPLE: A well mixed filtered aliquot of the sample is quantitatively transferred to a preweighed evaporating dish, evaporated and dried to constant weight at 180°C ±2°C.

4.0 REFERENCES:

4.1 "Standard Methods for the Examination of Water and Wastewater", 21st Edition, 2005, Method SM18-21 2540C.

5.0 PRESERVATION AND HOLD TIME:

6.1 Samples may be collected in plastic or glass. Samples must be cooled to 4°C at the time of sample collection and analyzed within 7 days from collection.

6.0 INTERFERENCES:

6.1 Highly mineralized waters containing significant concentrations of calcium, magnesium, chloride and/or sulfate content may be hygroscopic and will require prolonged drying, desiccation and rapid weighing.

7.0 APPLICABLE/ASSOCIATED SOPS

7.1 Safety

7.1.1 Employees must abide by the policies and procedures in the Corporate Safety Manual and this document.

7.1.2 Specific Safety Concerns or Requirements

7.1.2.1 N/A

7.1.3 Primary Materials Used

7.1.3.1 There are no materials used in this method that have a significant or serious hazard rating. NOTE: This list does not include all materials used in the method. A complete list of materials used in the method can be found in the reagents and materials section. Employees must review the information in the MSDS for each material before using it for the first time or when there are major changes to the MSDS.

7.2 Waste Management and Pollution Prevention

7.2.1 All waste will be disposed of in accordance with Federal, State and Local regulations. Where reasonably feasible, technological changes have been implemented to minimize the potential for pollution of the environment. Employees will abide by this method and the policies in section 13 of the Corporate Safety Manual for "Waste Management and Pollution Prevention."

7.2.2 Waste Streams Produced by the Method

7.2.2.1 The following waste streams are produced when this method is carried out.

7.2.2.1.1 Acidic sample waste generated by the analysis must be discarded down the acid neutralizing sink.

7.2.2.1.2 Contaminated filter and filter residue generated by the analysis must be discarded in the garbage.

8.0 PROCEDURE

8.1 Reagent

8.1.1 LCS standard from NSI or equivalent

8.2 Apparatus

8.2.1 100ml capacity evaporating dishes
8.2.2 Glass fiber filter disks, Whatman grade 934AH or equivalent.
8.2.3 Drying oven, 180 ±2°C
8.2.4 Desiccator
8.2.5 Analytical Balance, capable of weighing to 0.0001g
8.2.6 Filter holder, membrane filter funnel or Gooch crucible adapter
8.2.7 Suction flask, 500ml
8.2.8 Steambath or hotplate

8.3 Analysis

8.3.1 **Prepare evaporating dishes**: Heat a clean evaporating dish to 180±2 degrees C for 1 to 1.5 hours. Cool in desiccator and store until needed. Weigh immediately before use (to 0.0001g).

8.3.2 **Prepare glass fiber filter disc** by washing the disc with 3 successive 20ml volumes of distilled water, discard washings.

8.3.3 Assemble the filtering apparatus, and begin suction. Shake the sample and transfer 50ml to the funnel. (50ml for LCS)

8.3.4 Filter the sample through the glass fiber filter, and continue to apply vacuum to remove as much sample as possible.

8.3.5 Transfer 50ml of filtrate to a weighed evaporation dish and evaporate to dryness on a steambath or hotplate (without boiling). Rinse apparatus with 3 10ml portions of distilled water and discard washings.

8.3.6 Transfer to a 180 ±2°C oven for at least 1 hour.

8.3.7 Cool in a desiccator to balance temperature, and weigh (to 0.0001g).

8.4 Calculation

8.4.1 Calculate filterable residue as follows:

$$\text{Total Dissolved Solids, mg/l} = \frac{(A-B) \times (1000\text{mg/g})(1000\text{ml/l})}{C}$$

Where:

A = weight of sample + dish in g dried
B = weight of dish in g
C = volume of sample in ml

9.0 QC Criteria

QC ANALYSIS	FREQUENCY	QC CRITERIA	CORRECTIVE ACTION
Method Blank (MB)	One per Analytical Batch	Detection Limit	No corrective action required.
Laboratory Control Sample (LCS)	One per Analytical Batch	Lab Limits: 77-122%	Analyze a new aliquot of LCS; if still out stop analysis. Notify section supervisor and QA/QC Manager.
Duplicate	One per Analytical Batch	Lab Limits % RPD < 15%	Re-analyze; if precision criteria still not met determine if matrix or method is cause

10.0 DEFINITIONS

Analytical Batch - shall be defined as environmental samples that are analyzed together with the same method and personnel, using the same lots of reagents, not to exceed the analysis of 20 environmental samples.

Method Blank (MB) - A volume of reagent water carried thru the entire analytical process.

Laboratory Control Standard (LCS) - An aliquot of reagent water to which known quantities of the method analyte is added in the laboratory. The LCS is analyzed exactly like a sample, and its purpose is to determine whether the methodology is in control and whether the laboratory is capable of making accurate and precise measurements.

Matrix Duplicate (MD) or Duplicate (DU) – A second aliquot of the same sample taken in the laboratory and analyzed separately with identical procedures. Analyses of the sample and MD indicates precision associated with laboratory procedures, but not with sample collection, preservation, or storage procedures.

STANDARD OPERATING PROCEDURE

1.0 PROCEDURE TITLE: Oxygen, Dissolved

Approvals and Signatures

Laboratory Manager: Renée Cusack Date: 10/15/12

QA Managert: Maria G Pistre Date: 10/15/12

Section Supervisor Maria Date: 10/15/12

EH&S Officer: Ken Powell Date: 10/15/12

Control # 68

2.0 AREA OF APPLICABILITY: Inorganic Chemistry

3.0 SCOPE: The method is applicable to wastewaters and streams that contain nitrite and not more than 1mg ferrous iron/L.

4.0 PRINCIPLE: The sample is treated with divalent manganese solution, followed by a strong alkali. In the presence of iodide ions in an acidic solution, the oxidized manganese reverts to the divalent state, with the liberation of iodine equivalent to the original DO content.

5.0 REFERENCES

5.1 "Standard Methods for the Examination of Water and Wastewater", 18th –21st Edition, SM 4500 O C.

6.0 PRESERVATION AND HOLD TIME: Samples should be collected in BOD bottles and "Fixed" on site. Samples should be kept dark and analyzed within 8 hours of sample collection.

7.0 INTERFERENCES

7.1 Oxidizing and reducing agents, nitrate ion, ferrous iron, and organic matter may interfere with the dissolved oxygen test.

8.0 APPLICABLE/ASSOCIATED SOPS

8.1 Safety

8.1.1 Employees must abide by the policies and procedures in the Corporate Safety Manual, Radiation Safety Manual and this document.

8.1.2 Specific Safety Concerns or Requirements

8.1.2.1 None

8.1.3 Primary Materials Used

8.1.3.1 The following is a list of the materials used in this method, which have a serious or significant hazard rating. **NOTE: This list does not include all materials used in the method. The table contains a summary of the primary hazards listed in the MSDS for each of the materials listed in the table.** A complete list of materials used in the method can be found in the reagents and materials section. Employees must review the information in the MSDS for each material before using it for the first time or when there are major changes to the MSDS.

Material (1)	**Hazards**	**Exposure Limit (2)**	**Signs and symptoms of exposure**
Sulfuric Acid	Corrosive Oxidizer Dehydrator Poison Carcinogen	1 mg/m3-TWA	Inhalation produces damaging effects on the mucous membranes and upper respiratory tract. Symptoms may include irritation of the nose and throat, and labored breathing. Symptoms of redness, pain, and severe burn can occur. Contact can cause blurred vision, redness, pain and severe tissue burns. Can cause blindness.
1 – Always add acid to water to prevent violent reactions.			
2 – Exposure limit refers to the OSHA regulatory exposure limit.			

8.2 Waste Management and Pollution Prevention

8.2.1 All waste will be disposed of in accordance with Federal, State and Local regulations. Where reasonably feasible, technological changes have been implemented to minimize the potential for pollution of the environment. Employees will abide by this method and the policies in section 13 of the Corporate Safety Manual for "Waste Management and Pollution Prevention."

8.2.2 Waste Streams Produced by the Method

8.2.2.1 The following waste streams are produced when this method is carried out.

8.2.2.1.1 Titrated samples must be discarded down the acid neutralizing sink.

9.0 PROCEDURE

9.1 Reagents

- 9.1.1 Manganous Sulfate Solution
  - 9.1.1.1 Commercially prepared, HACH manganous sulfate Powder Pillows (used in field services).
  - 9.1.1.2 An alternative is the use of commercially prepared reagent Lab Chem or equivalent.

9.2 Alkaline iodide-azide solution

- 9.1.1 Commercially prepared, Hach alkaline iodide-azide reagent powder pillows (used in field services).
- 9.1.2 An alternative is the use of commercially prepared, Lab Chem or equivalent.

9.3 Sulfuric acid: Concentrated

9.4 Starch Indicator: commercially prepared solution from RICCA Chemical or equivalent.

9.5 Sodium Thiosulfate 0.025M: commercially prepared solution.

9.6 Apparatus

- 9.6.1 300mL sample bottles
- 9.6.2 Pipettes capable of delivering 2.0mL ± 0.10mL

10.0 ANALYSIS

10.1 If sample is prepped in the field go directly to step 10.2

- 10.1.1 Add Manganous sulfate powder pillow to the sample (or 1.0mL of $MnSO_4$ Solution).
- 10.1.2 Add alkaline iodide-azide powder pillow (or 1.0mL of Alkaline Iodide-azide Solution), cap the bottle and invert the sample bottle to mix.

10.2 Let the flock settle to the bottom and add 1.0ml of concentrated sulfuric acid. Invert the bottle again.

10.3 Transfer 200mL of sample into a 500mL wide mouth flask and titrate with 0.025M thiosulfate solution to a pale straw color.

10.4 Add 1-2mL of starch solution and continue to titrate to the first disappearance of the blue color.

11.0 Calculation:

11.1 DO mg/L = (initial buret reading - final buret reading)

11.2 For a titration of 200mL sample, 1mL 0.025M $Na_2S_2O_3$ is equivalent to 1.0mg/L DO.

12.0 Definitions: None

STANDARD OPERATING PROCEDURE

1.0 PROCEDURE TITLE: Conductivity

Approvals and Signatures

Laboratory Manager: Renée Cusack Date: 5/26/10
QA Manager: Maria A. Pistole Date: 5/26/10
Section Supervisor Renée Cusack Date: 5/26/10
EH&S Officer: Lisa Savage Date: 5/27/10
Control # 100

2.0 AREA OF APPLICABILITY: Inorganic Chemistry

3.0 SCOPE: The method is applicable to drinking, surface, and saline waters, domestic and industrial wastes and acid rain.

4.0 PRINCIPLE: The specific conductance of a sample is measured by use of a self-contained conductivity meter. Samples are preferably analyzed at 25 degrees C if not corrections are made by the conductivity meter and results are reported at 25 degrees C.

5.0 REFERENCES

5.1 "Standard Methods for the Examination of Water and Wastewater", 18th – 21st Edition, Method SM 2510 B.
5.2 "Methods for Chemical Analysis of Water and Wastes", EPA-821-C-99-004, June 1999, Method 120.1.

6.0 PRESERVATION AND HOLD TIME

6.1 Samples may be collected in plastic or glass. Samples must be kept cold at 4°C. Holding time is 28 days from collection.

7.0 INTERFERENCES

7.1 Molecules of organic compounds that do not dissociate in aqueous solution conduct a current very poorly.

8.0 APPLICABLE/ASSOCIATED SOPS

8.1 SAFETY

8.1.1 Employees must abide by the policies and procedures in the Corporate Safety Manual, Radiation Safety Manual and this document.

8.1.2 SPECIFIC SAFETY CONCERNS OR REQUIREMENTS

8.1.2.1 Not Applicable

8.1.3 PRIMARY MATERIALS USED

8.1.3.1 The following is a list of the materials used in this method, which have a serious or significant hazard rating. NOTE: This list does not include all materials used in the method. The table contains a summary of the primary hazards listed in the MSDS for each of the materials listed in the table. A complete list of materials used in the method can be found in the reagents and materials section. Employees must review the information in the MSDS for each material before using it for the first time or when there are major changes to the MSDS.

Material (1)	Hazards	Exposure Limit (2)	Signs and symptoms of exposure
Isopropanol	Flammable	400 ppm-TWA	Flammable liquid and vapor. Harmful if swallowed or inhaled. Causes irritation to eyes and respiratory tract. Affects central nervous system. May be harmful if absorbed through skin. May cause irritation to skin.
1 – Always add acid to water to prevent violent reactions.			
2 – Exposure limit refers to the OSHA regulatory exposure limit.			

8.2 Waste Management and Pollution Prevention Section

8.2.1 All waste will be disposed of in accordance with Federal, State and Local regulations. Where reasonably feasible, technological changes have been implemented to minimize the potential for pollution of the environment. Employees will abide by this method and the policies in section 13 of the Corporate Safety Manual for "Waste Management and Pollution Prevention."

8.2.2 Waste Streams Produced by the Method

8.2.2.1 The following waste streams are produced when this method is carried out.

8.2.2.1.1 Waste Isopropanol from cleaning probes must be disposed of down the acid neutralizing sink.

9.0 PROCEDURE

9.1 Reagents

9.1.1 Standard Potassium Chloride Solution

9.1.1.1 Purchased from VWR, Lab Chem or equivalent at certified concentrations of 500 µmhos , and 1000 µmhos .

9.1.1.2 Purchased, a certified solution at a concentration of 1413 µmhos at 25 ° C for calibration of field meter.

9.2 Apparatus

9.2.1 Self-contained Conductivity Instrument, range 1 to 1000 µmhos /cm.

9.2.2 Conductivity cell-platinum-electrode type with built in thermometer.

9.3 Analysis

Cell Calibration

9.3.1 Rinse conductivity cell with DI water.

9.3.2 Refer to instruction manual for calibration and determination of cell constant. (The cell constant is calculated by the instrument.)

Sample Analysis

9.3.3 Allow samples to come to room temperature. (The conductivity meter compensates for differences in temperature.)

9.3.4 Measure the sample resistance as conductivity.

9.3.5 Report results as conductivity in µmhos.

9.4 Calculation

9.4.3 Calculate conductivity:

Read result µmhos from instrument.

10.0 QUALITY CONTROL

QC ANALYSIS	FREQUENCY	QC CRITERIA	CORRECTIVE ACTION
Cell Constant	Determined at time of calibration.	Cell constant is usually 0.1 or less.	If cell constant is unusually high or if cleaning is required see section manager or QA manager.
Laboratory Control Sample	Read with every batch	Reading must be ± 5%	Check cell to determine if needs cleaning. Clean if necessary. Re-calibrate.
Method Blank	Read with every batch	Less than 2 µmhos/cm at 25°C.	If greater than 2 micromhos/cm at 25°C, notify the section supervisor and QA Manager.
Matrix Dulpicate	Every 10 samples or one per batch which every is more frequent	Reading must be ± 10%	Check cell to determine if needs cleaning. Clean if necessary. Re-calibrate.

11.0 DEFINITIONS

Analytical Batch - shall be defined as environmental samples that are analyzed together with the same method and personnel, using the same lots of reagents, not to exceed the analysis of 20 environmental samples.
Method Blank (MB) - A volume of reagent water carried thru the entire analytical process.
Laboratory Control Standard (LCS) - An aliquot of reagent water to which known quantities of the method analyte is added in the laboratory. The LCS is analyzed exactly like a sample, and its purpose is to determine whether the methodology is in control and whether the laboratory is capable of making accurate and precise measurements.
Matrix Duplicate (MD) or Duplicate (DU) – A second aliquot of the same sample taken in the laboratory and analyzed separately with identical procedures. Analyses of the sample and MD indicates precision associated with laboratory procedures, but not with sample collection, preservation, or storage procedures.

STANDARD OPERATING PROCEDURE

1.0 PROCEDURE TITLE: Titrimetric Alkalinity

Approvals and Signatures

Laboratory Manager: Date: 6/26/13

QA Manager: Date: 6/26/13

Section Supervisor: Date: 6/26/13

EH&S Officer: Date: 6/26/13

Control #: 12

2.0 AREA OF APPLICABILITY: Inorganic Chemistry

3.0 SCOPE

3.1 This method is applicable to drinking, surface, and saline waters, domestic and industrial wastes.

3.2 This method is suitable for all concentration ranges of alkalinity, however, appropriate aliquots should be used to avoid a titration volume greater than 50 mL.

3.3 The reporting limit for alkalinity is 5.0mg/L.

4.0 PRINCIPLE

4.1 Hydroxyl ions present in a sample as a result of dissociation or hydrolysis of solutes react with additions of standard acid. Alkalinity thus depends on the endpoint pH used. For routine or automated analysis an endpoint of 4.5 is used for Total Alkalinity and 8.3 for Phenolphthalein Alkalinity.

4.2 Because the alkalinity of many surface waters is primarily a function of carbonate, bicarbonate and hydroxide content, it is taken as and indication of the concentration of these constituents.

4.3 For alkalinities less than 20 mg/L stop titration at a pH in the range 4.3 to 4.7 and record volume and exact pH. Carefully add additional titrant to reduce the pH exactly 0.30 pH unit and again record volume.

NOTE: The sample must not be filtered, diluted, concentrated, or altered in anyway.

5.0 REFERENCES

5.1 "Standard Methods for the Examination of Water and Wastewater", 21st Edition, 2005, Method SM 2320 B.

5.2 Environmental Laboratory Approval Program Certification Manual, Item No. 242, 1/3/08.

5.3 NELAC, Quality Systems, 6/5/2003.

6.0 PRESERVATION AND HOLD TIME

6.1 Samples may be collected in separate plastic or glass bottle completely filled to the exclusion of air. Samples must be cooled to a temperature of 4° C and analyzed within 14 days of collection.

7.0 INTERFERENCES

7.1 Soaps, oily matter, suspended solids or precipitates may interfere with the response of the glass electrode. To correct for this, pause for a few seconds between each addition of titrant. Do not filter, dilute, concentrate or alter sample.

7.2 Substances, such as salts of weak organic and inorganic acids present in large concentrations may cause interference in the electrometric pH measurements.

8.0 APPLICABLE/ASSOCIATED SOPS

8.1 Safety: Employees must abide by the policies and procedures in the Corporate Safety Manual, Radiation Safety Manual and this document.

8.1.1 Specific Safety Concerns or Requirements

8.1.1.1 None

8.1.2 Primary Materials Used

8.1.2.1 The following is a list of the materials used in this method, which have a serious or significant hazard rating. NOTE: This list does not include all materials used in the method. The table contains a summary of the primary hazards listed in the MSDS for each of the materials listed in the table. A complete list of materials used in the method can be found in the reagents and materials section. Employees must review the information in the MSDS for each material before using it for the first time or when there are major changes to the MSDS.

Material (1)	Hazards	Exposure Limit (2)	Signs and symptoms of exposure
Sulfuric Acid	Corrosive Oxidizer Dehydradator	1 mg/m^3	This material will cause burns if comes into contact with the skin or eyes. Inhalation of vapors will cause irritation of the nasal and respiratory system.
1 – Always add acid to water to prevent violent reactions.			
2 – Exposure limit refers to the OSHA regulatory exposure limit.			

8.2 Waste Management and Pollution Prevention

8.2.1 All waste will be disposed of in accordance with Federal, State and Local regulations. Where reasonably feasible, technological changes have been implemented to minimize the potential for pollution of the environment. Employees will abide by this method and the policies in section 13 of the Corporate Safety Manual for "Waste Management and Pollution Prevention."

8.2.2 Waste Streams Produced by the Method

8.2.2.1The following waste streams are produced when this method is carried out.

8.2.2.1.1 Acidic waste generated by the analysis must be disposed down the acid neutralizing sink in wet chemistry.

9.0 PROCEDURE

9.1 Reagents

9.1.1 Sodium Carbonate (Na_2CO_3) Solution (0.05N): Purchased from Ricca Chemical Company or equivalent. (Standard Concentration 2500mg/L)

9.1.2 Standard acid (Sulfuric Acid), 0.1 N: Dilute 2.8ml concentrated H_2SO_4 to 1 liter with DI water. Standardize versus 10ml of 0.05N Na_2CO_3 solution by titrating potentiometrically to pH of about 4.5. Lift electrode and rinse into beaker. Calculate normality using:

$$N = \frac{A \times B}{C}$$

where:
A = N Na2CO3
B = mL Na2CO3 solution
C = mL acid used to inflection point

NOTE: 0.1N sulfuric acid is used primarily for manual tirtrations and the 0.02N acid is used primarily for the automated method.

9.1.3. Standard Acid (0.02N Sulfuric or Hydrochloric): Dilute 20ml of 1N sulfuric acid (see 9.1.4 for preparation instructions) to 1 liter with DI water. Standardize by potentiometric titration of 25.0ml of a 50mg/L Na_2CO_3 solution using the Mantech Autotitrator. Repeat titration 2 times for a total of three titrations. Calculate the average volume titrated to inflection point. Use the average volume titrated to calculate the normality by the equation in 9.1.2.

9.1.4 1N Sulfuric Acid: Dilute 2.8 mL concentrated sulfuric acid to a final volume of 100 mL with DI water.

9.2 Apparatus

- 9.2.1 Manual Titration
  - 9.2.1.1 Electronic pH meter: Standardize and calibrate according to manufacturer's instructions. If automatic temperature compensation is not provided, make titration at room temperature
  - 9.2.1.2 Magnetic stir plate and stir bars
  - 9.2.1.3 Volumetric pipettes and flasks
  - 9.2.1.4 Burets, Borosilicate glass, (50ml Class A or recently calibrated)
- 9.2.2 Automated Titration
  - 9.2.2.1 Mantech Automated Analyzer, equipped with automatic temperature compensation pH probe

9.3 Manual Procedure

- 9.3.1 Manual Titration, Please note: At present manual titration is used for sludge samples only. All other samples are analyzed on the ManTech Automated Analyzer.
  - 9.3.1.1 Sample size
    - 9.3.1.1.1 Use a sufficiently large volume of titrant to obtain good precision while keeping volume low enough to permit sharp end point.
    - 9.3.1.1.2 For sludge samples use 10 mL
  - 9.3.1.2 Prepare a method blank (MB) using DI water at same volume used for sample.
  - 9.3.1.3 Prepare laboratory control sample (LCS) according to manufactures instructions.
  - 9.3.1.4 Prepare ICV sample.
    - 9.3.1.4.1 Add 5ml of 2500mg/L sodium carbonate stock solution to final volume of 10ml using DI water. (concentration ICV=1250mg/L)
  - 9.3.1.5 Choose a sample to spike, add 1ml of 2500mg/L sodium carbonate standard to final volume of 10ml using designated sample. (Concentration of spike =250mg/L)
  - 9.3.1.6 Place 10ml sample in a beaker with magnetic stir bar.
  - 9.3.1.7 Place beaker on magnetic stir plate.
  - 9.3.1.8 Measure pH of sample
  - 9.3.1.9 Record initial volume of the buret on bench sheet. Add standard acid (9.1.2 or 9.1.3), being careful to stir thoroughly but gently to allow meter to obtain equilibrium.
  - 9.3.1.10 Titrate to pH 4.5. Record volume of titrant.
  - 9.3.1.11 Calculate data. See 9.4.
- 9.3.2 Alternate Manual Procedure for regular water samples.

- 9.3.2.1 Follow procedure outlined in 9.3.1 with the following modifications:
  - 9.3.2.1.1 Sample size = 50ml
  - 9.3.2.1.2 ICV, Add 2ml of 2500mg/L sodium carbonate stock solution to final volume of 50ml using DI water. (concentration ICV=100mg/L)
  - 9.3.2.1.3 MS, add 0.4 ml of 2500mg/L sodium carbonate standard to final volume of 50ml using designated sample. (Concentration of spike =20mg/L)
- 9.3.2.2 Potentiometric titration of low alkalinity
  - 9.3.2.2.1 For alkalinity of <20mg/l titrate 100ml as above with alternate procedure QC.
  - 9.3.2.2.2 Stop titration at pH in range of 4.3-4.7, record volume and exact pH. Very carefully add titrant to lower pH exactly 0.3 pH units and record volume.

9.4 Calculations

9.4.1 Total Alkalinity, Titration to end-point pH 4.5

$$\text{Alkalinity, mg CaCO3/L} = \frac{\text{AxNx50000}}{\text{ml sample}}$$

where:
A= ml standard acid used
N= normality of standard acid

9.4.2 Potentiometric titration of low alkalinity:

$$\text{Total Alkalinity, mg/l CaCO3} = \frac{(2B - C) \times N\ 50000}{\text{ml of sample}}$$

where:
B = ml of titrant to first recorded pH
C = ml of titrant to first recorded pH plus the ml titrant to reach pH 0.3 units lower.
N = normality of acid

9.4.3 Phenolphtalein Alkalinity, Titration to end-point 8.3

$$\text{Alkalinity, mg CaCO3/L} = \frac{\text{AxNx50000}}{\text{ml sample}}$$

where:
A= ml standard acid used
N= normality of standard acid

Table 1: Alkalinity Relationships

Result of Titration	Hydroxide Alkalinity as $CaCO_3$	Carbonate Alkalinity as $CaCO_3$	Bicarbonate Concentration As $CaCO_3$
P=0	0	0	T
P< ½ T	0	2P	T- 2P
P= ½ T	0	2P	0
P > ½ T	2P- T	2 (T- P)	0
P=T	T	0	0

9.5 Automated Alkalinity-ManTech Procedure

9.5.2 MB= 50ml DI water.

9.5.3 ICV/CCV, add 10ml of 2500 mg/L sodium carbonate stock solution to final volume of 500 ml with DI water. (Concentration= 50 mg/L)

9.5.4 Prepare LCS as per manufactures directions.

9.5.5 Designate a sample for a MD, use same sample for MS.

9.5.6 MS, add 500ul of the 2500 mg/L sodium carbonate stock solution to a final volume of 50 ml with sample.

9.5.7 Set up instrument according to manufactures instructions.

9.5.8 Pour samples into sample vials.

9.5.9 Place in autosampler according to sequence. Sequence must begin as follows: DI, STD @ 50, ICV, ICB/MB, LCS. a CCV and CCB must be analyzed every 10 samples at the end of analytical run. The LCS is to be considered as a sample.

10.0 QUALITY CONTROL

QC ANALYSIS	FREQUENCY	QC CRITERIA	CORRECTIVE ACTION
Laboratory Control Sample (LCS)	Minimum One per analytical batch of 20 samples or less.	Lab Limits 80-114%	Analyze a new aliquot of LCS; if still out discontinue analysis and determine problem.
Initial Calibration Verification (ICV)	Daily	85-115%	Re-analyze; if still out discontinue analysis and determine problem.
Continuing Calibration Verification (CCV), ManTech Only	One every 10 samples and at end of analytical sequence.	85-115%	If outside limits. Restart run beginning at last good CCV; if still out discontinue analysis and determine problem.
Method Blank (MB)	Minimum One per analytical batch of 20 samples or less.	< RL Limit	Re-analyze; if still > RL Limit investigate cause and reanalyze

QC ANALYSIS	FREQUENCY	QC CRITERIA	CORRECTIVE ACTION
Continuing Calibration Blank (CCB) (ManTech Only)	One every 10 samples and at end of analytical sequence	< RL Limit	If outside limits. Restart run beginning at last good CCB; if still out discontinue analysis and determine problem.
Matrix Spike (MS)	One fortified sample per analytical batch of 10 samples	60-139%, until in-house limits are generated	If recovery is out, re-run sample once. If still out and LCS is within limits, report data using appropriate data qualifiers.
Matrix Duplicate (MD)	One per analytical batch of 10, minimum of one per batch.	RSD $\leq$ 10.0%	If RSD is out reanalyze the duplicate sample. If still out suspect matrix problem. If matrix problem is encountered analyze an additional sample duplicate of another sample in the batch.
Initial Demonstration of Capability (IDOC) MUST BE PREFORMED BEFORE SAMPLES CAN BE ANALYZED	At least 4 aliquots of a standard 1-4 times the reporting limit shall be prepared and analyzed as per method either concurrently or over a period of days. This must be done for all new personnel and at any time there is a change in instrumentation or method.	Mean recovery 85-115% Standard Deviation $\leq$ 10.0%	Locate and correct the source of the problem and reanalyze. If still problematic inform QA manager.
Continued Demonstration of Capability	Must be preformed annually, by above IDOC method. Alternatively a successful PT result may be substituted.	Mean recovery 85-115% Standard Deviation $\leq$ 10.0%	Locate and correct the source of the problem and reanalyze. If still problematic inform QA manager.
MDL (Method detection limit)	At least once a year perform 7 successive analysis of a standard at 2-3 times the LOD.	Refer to MDL SOP.	

11.0 Definitions

Alkalinity of a water is its acid neutralizing capacity. It is the sum of all titratable bases.

An **Analytical batch** shall be defined as environmental samples that are analyzed together with the same method and personnel, using the same lots of reagents, not to exceed the analysis of 20 environmental samples.

Bicarbonate (HCO_3^-) Alkalinity is present if phenolphthalein alkalinity is less than half the total alkalinity.

Carbonate (CO_3^{2-}) Alkalinity is present when phenolphthalein alkalinity is not zero but is less than the total alkalinity.

Continued Demonstration of Capability or CDOC must be preformed annually to show an analysts continued proficiency performing the test method. It shall consist of a quality control sample that is obtained from and outside source. The standard should be 1-4X the LOQ and at least four aliquots shall be prepared and analyzed according to the test method either concurrently or over a period of days. The resulting data shall be evaluated by the QA manager or section supervisor to determine if it meets acceptance criteria. Also, a passing PT sample can be substituted.

Hydroxide (OH^-) Alkalinity is present if the phenolphthalein alkalinity is less than half the total alkalinity.

Initial Demonstration of Capability or IDOC must be made prior to using any test method, and at any time there is a change in instrument type, personnel or test method. It shall consist of a quality control sample that is obtained from and outside source. The standard should be 1-4X the LOQ and at least four aliquots shall be prepared and analyzed according to the test method either concurrently or over a period of days. The resulting data shall be evaluated by the QA manager or section supervisor to determine if it meets acceptance criteria.

Initial Calibration Verification or ICV is a standard used to determine the state of calibration of an instrument between periodic recalibrations. It is run before any samples are run to insure the method is in control.

LCS or Laboratory Control Standard is a standard, usually certified by and outside agency, used to measure the bias in a procedure. It is used to evaluate the performance of the total analytical system, including all preparation and analysis steps. Results of the LCS are compared to established criteria and, if found to be outside these criteria, indicates that the analytical system is "out of control". Any affected samples associated with an out of control LCS shall be reprocessed for re-analysis or the results reported with appropriate data qualifying codes. An LCS shall be analyzed at a minimum of 1 per analytical batch. The LCS is a quality system matrix, known to be free of analytes of interest, spiked with known and verified concentrations of analytes.

The **LOQ or Limit of Quantitation is the RL or reporting limit**, the constituent concentration that produces a signal sufficiently greater than the blank that it can be detected within specified levels by good laboratories during routine operating conditions.

The **Matrix Duplicate or MD is a** duplicate aliquot of a sample processed and analyzed independently; under the same laboratory conditions; also referred to as Sample Duplicate.

The **Matrix Spike or MS** is a field sample to which a known amount of target analyte(s) is added.

The **Method Blank or MB** is used to assess the preparation batch for possible contamination during the preparation and processing steps. The method blank shall be processed along with and under the same conditions as the associated samples to include all steps of the analytical procedure. Procedures shall be in place to determine if a method blank is contaminated. Any affected samples associated with a contaminated method blank shall be reprocessed for analysis or the results reported with appropriate data qualifying codes.

Method Detection Limit (MDL) - The minimum concentration of an analyte confirmed by qualitative identification of the analyte(s) in a QC sample in each quality system matrix containing the analyte at no more than 2-3X the MDL for a single analyte tests and 1-4X the MDL for multiple analyte tests that can be identified, measured, and reported with 99% confidence that the analyte concentration is greater than zero but less than the reporting limit (RL). See method SOP for further qualifications.

Phenolphtalein or palk is the term traditionally used for the quality measured by titration to pH 8.3 irrespective of the color indicator, if any, used in the determination.

STANDARD OPERATING PROCEDURE

1.0 PROCEDURE TITLE: Sulfide, Methylene Blue Method

Approvals and Signatures

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QA Manager: Date: 11/21/12

Section Supervisor Date: 11/21/12

EH&S Officer: Date: 11/26/12

Control # 102

2.0 AREA OF APPLICABILITY: Inorganic Chemistry

3.0 SCOPE: The procedure is applicable to the measurement of total sulfides in drinking, surface, and saline water, domestic and industrial wastes.

4.0 PRINCIPLE: Iodine reacts with sulfide in acid solution, oxidizing it to sulfur.

5.0 REFERENCES:

5.1 "Standard Methods for the Examination of Water and Wastewater", 21st Edition, 2005, Method 4500-S^{2-}D.

6.0 PRESERVATION AND HOLD TIME: Cool the sample to 4°C, add zinc acetate plus sodium hydroxide to pH>9. Hold time 7 days from sample collection.

7.0 INTERFERENCES: Interferences from reducing substances that react with iodine, including thiosulfate, sulfite and various organic compounds, both solid and dissolved.

8.0 APPLICABLE/ASSOCIATED SOPS

8.1 SAFETY

8.1.1 Employees must abide by the policies and procedures in the Corporate Safety Manual and this document.

8.1.2 SPECIFIC SAFETY CONCERNS OR REQUIREMENTS

8.1.2.1 Hydrogen sulfide (H_2S) gas is generated by the addition of sulfuric acid. Inhalation of H_2S gas can cause headache, dizziness, nausea, and unconsciousness and potentially death.

8.1.3 PRIMARY MATERIALS USED

8.1.3.1 The following is a list of the materials used in this method, which have a serious or significant hazard rating. NOTE: This list does not include all materials used in the method. The table contains a summary of the primary hazards listed in the MSDS for each of the materials listed in the table. A complete list of materials used in the method can be found in the reagents and materials section. Employees must review the information in the MSDS for each material before using it for the first time or when there are major changes to the MSDS

Material (1)	Hazards	Exposure Limit (2)	Signs and symptoms of exposure
Ferric Chloride for Sulfide	Corrosive		Irritating to the eyes and skin. Ingestion will cause moderate to severe irritation of the mouth and stomach. Repeated ingestion of large doses may cause liver damage.
Sodium Hydroxide	Corrosive	2 mg/m^3-Ceiling	Severe irritant. Effects from inhalation of dust or mist vary from mild irritation to serious damage of the upper respiratory tract, depending on severity of exposure. Symptoms may include sneezing, sore throat or runny nose. Contact with skin can cause irritation or severe burns and scarring with greater exposures. Causes irritation of eyes, and with greater exposures it can cause burns that may result in permanent impairment of vision, even blindness.
Sodium Sulfide	Corrosive	10 ppm-TWA 15 ppm-STEL	Will form Hydrogen Sulfide (HS) gas if combined with strong acids. Inhalation of HS gas may be fatal. Symptoms include painful conjunctivitis, headache, nausea, dizziness, coughing and, in extreme cases, pulmonary edema and possible death. Irritant. Contact with skin can produce serious caustic burns with painful inflammation and possible destruction of tissue. Inflammation, tearing and pain may be expected. Severe contact can cause destruction of tissue.
Sulfuric Acid	Corrosive Oxidizer Dehydrator Poison Carcinogen	1 mg/m^3-TWA	Inhalation produces damaging effects on the mucous membranes and upper respiratory tract. Symptoms may include irritation of the nose, throat, and labored breathing. Symptoms of redness, pain, and severe burn can occur. Contact can cause blurred vision, redness, pain and severe tissue burns. Can cause blindness.
1 – Always add acid to water to prevent violent reactions.			
2 – Exposure limit refers to the OSHA regulatory exposure limit.			

8.2 WASTE MANAGEMENT AND POLLUTION PREVENTION

8.2.1 All waste will be disposed of in accordance with Federal, State and Local regulations. Where reasonably feasible, technological changes have been implemented to minimize the potential for pollution of the environment. Employees will abide by this method and the policies in section 13 of the Corporate Safety Manual for "Waste Management and Pollution Prevention."

8.2.2 Waste Streams Produced by the Method

8.2.2.1 The following waste streams are produced when this method is carried out.

8.2.2.1.1 Aqueous acidic material generated by this method is discarded down the acid neutralizing sink in wet chemistry.

9.0 PROCEDURE

9.1 Reagents

9.1.1 Amine-sulfuric Acid Reagent

9.1.1.1 Purchase commercially from LabChem or equivalent

9.1.2 Ferric Chloride for sulfide

9.1.2.1 Purchase commercially from LabChem or Equivalent

9.1.3 Sulfuric Acid Solution, 1+1 H_2SO_4

9.1.3.1 **ALWAYS** add **ACID TO WATER**

9.1.4 Ammonium Phosphate Buffer Solution-40% (purchase commercially from LabChem or equivalent)

9.1.4.1 To prepare if not purchased: Dissolve 400g (NH4)2HPO4 into 800mL DI water.

9.1.5 Sodium Sulfide Stock Solution-3%

9.1.5.1 Purchase commercially from LabChem or equivalent

9.1.5.2 Prepare a five point curve of working standards in the range from 0.1 mg/L to 1.0 mg/L.

Stock Solution Concentration	Volume of Stock Solution	Volume of Distilled Water	Final Standard Concentration
1.0 mg/L	0	5.0 mL	0mg/L (Blank)
1.0 mg/L	0.050 mL	4.95 mL	0.1 mg/L
1.0 mg/L	0.150 mL	4.85 mL	0.3 mg/L
1.0 mg/L	0.250 mL	4.75 mL	0.5 mg/L
1.0 mg/L	0.400 mL	4.60 mL	0.8 mg/L
1.0 mg/L	0.500 mL	4.50 mL	1.0 mg/L

9.1.5.3 Prepare standard at reporting level, continuing calibration check standard and matrix spike at midpoint of curve or lower.

9.1.6 Second source Sulfide standard, NSI or equivalent
  9.1.6.1 Prepare Laboratory Control Standard (LCS)/Initial Calibration Verification Standard (ICV) at midpoint or lower on curve.

9.2 Apparatus
  9.2.1 Test Tubes (16mm x 100mm)
  9.2.2 Spectrophotometer
    9.2.2.1 For use at a wavelength of 664nm with cells providing light paths of 1 cm and 1 mm

9.3 Analysis
  9.3.1 Confirm pH >9 using pH paper, add more NaOH if necessary.
  9.3.2 To two test tubes (A & B), transfer 5.0mL of well mixed sample to each of the 2 matched tubes.
  9.3.3 **For Soils** Weigh 20g sample into 1 liter plastic bottle.
    9.3.3.1 Add 1 liter DI water and let sit overnight.
    9.3.3.2 Preserve using 2 mL of 10N NaOH and 2 squirts of zinc acetate.
    9.3.3.3 Let sit overnight.
    9.3.3.4 Proceed to 9.3.1.
  9.3.4 Add to tube "A" 0.330 mL of amine sulfuric acid solution and 0.10 mL (2 drops) of ferric chloride.
  9.3.5 **Mix Immediately** by inverting slowly, only once (using parafilm).
    9.3.5.1 **Excessive mixing causes low results by loss of sulfide as a gas before it has time to react.**
  9.3.6 Add to tube "B" 0.330 mL 1+1 H_2SO4 and 0.10ml (2 drops) ferric chloride and mix.
  9.3.7 The presence of sulfide will be indicted by the appearance of blue color in tube A.
  9.3.8 Wait 3-5 minutes and add 1.0 mL of ammonium phosphate buffer solution to each tube.
  9.3.9 Wait 3-15 minutes and make the color comparison.
  9.3.10 Read on the spec at 664nm.
  9.3.11 Use tube "B" to zero the spec. The spectrophotometer must be zeroed between each sample using tube "B" from each sample.

9.4 Calculation
  9.4.1 Prepare a standard curve by plotting the absorbance value of the standards verses the corresponding sulfide concentrations in mg/L.

10.0 QUALITY CONTROL

QC ANALYSIS	FREQUENCY	QC CRITERIA	CORRECTIVE ACTION
Initial Demonstration of Capability: Prepare and analyze 4 blank spikes at 1-4 times reporting limit (RL).	Each new analyst must analyze IDC prior to the unsupervised analysis of samples	80-120%	Repeat IDC. If still out; see QA Manager.

QC ANALYSIS	FREQUENCY	QC CRITERIA	CORRECTIVE ACTION
Method Detection Limit Study (MDL)	Prepare 7 spike blanks at a concentration near the suspected reporting limit at method start-up and then 1 per year, for each new analyst or whenever the method's conditions are changed.	Calculate mean recovery and standard deviation.	The calculated MDL should not be less than 10% of the concentration of the standard analyzed. If so, the MDL study needs to be performed at a lower concentration.
Initial Calibration	Initially then as needed when 2nd source standard is out of control limits.	R≥ 0.995	Re-analyze standards; if still problematic, check stock standards and reagents
Method Blank (MB)/Initial Calibration Blank (ICB)	One per Analytical Batch	< Reporting Limit (RL)	Re-analyze; if still out, check reagents.
Initial Calibration Verification (ICV)/Laboratory Control Standard (LCS)	One per analytical batch	51-122% **Lab Limits**	Remake standard and re-analyze. If failure still occurs, re-analyze calibration curve.
Continuing Calibration Verification (CCV)	Every ten samples and as final standard	90-110%	Analyze a new aliquot; if still out re-analyze calibration and reanalyze all samples not bracketed by passing CCV.
Continuing Calibration Blank (CCB)	Every ten samples and as final blank	< Reporting Limit	Re-analyze; if still out, check reagents and reanalyze all samples not bracketed by pass CCB.
Standard at Reporting Level (RS)	One per Analytical Batch	50-150%	None
Duplicate (DU)	One per matrix , or per Analytical Batch when sample volume permits.	Lab Limits RPD ≤20%	Re-analyze; if precision criteria still not met determine if matrix or method is cause.
Spike (MS)	One per matrix , or per Analytical Batch when sample volume permits.	46-154% **Lab Limits**	Re-analyze, if percent recovery criteria still not met matrix interference possible cause.

11.0 Definitions

Analytical Batch - shall be defined as environmental samples that are analyzed together with the same method and personnel, using the same lots of reagents, not to exceed the analysis of 20 environmental samples.

Continued Calibration Verification (CCV) solution - A solution prepared from the dilution of stock standard solutions. Used to check the calibration.

Initial Demonstration of Capability of IDOC must be made prior to using any test method, and at any time there is a change in instrument type, personnel or test method. It shall consist of a quality control sample that is obtained from and outside source. The standard should be 1-4X the

LOQ and at least four aliquots shall be prepared and analyzed according to the test method either concurrently or over a period of days. The resulting data shall be evaluated by the QA manager or section supervisor to determine if it meets acceptance criteria.

Initial Calibration Verification or ICV is a second source standard (not calibration standard) used to determine the state of calibration of an instrument between periodic recalibrations. It is run before any samples are run to insure the method is in control.

Laboratory Control Standard (LCS) - An aliquot of reagent water to which known quantities of the method analytes are added in the laboratory. The LCS is analyzed exactly like a sample, and its purpose is to determine whether the methodology is in control and whether the laboratory is capable of making accurate and precise measurements. The LCS must be run with each batch of 20 samples.

Matrix Duplicate (MD) or Duplicate (DU) – A second aliquot of the same sample taken in the laboratory and analyzed separately with identical procedures. Analyses of the sample and MD indicates precision associated with laboratory procedures, but not with sample collection, preservation, or storage procedures.

Matrix Spike (MS) - An aliquot of an environmental sample to which known quantities of the method analytes are added in the laboratory. The MS is analyzed exactly like a sample, and its purpose is to determine whether the sample matrix contributes bias to the analytical results. The background concentrations of the analytes in the sample matrix must be determined in a separate aliquot and the measured values in the MS corrected for background concentrations. If the recovery is not set in the method it is to be calculated using Standard Method Section 1020B.12.

Method Blank (MB) - An aliquot of reagent water or other blank matrices that are treated exactly as a sample including exposure to all glassware, equipment, solvents, reagents, and internal standards that are used with other samples. The MB is used to determine if method analytes or other interferences are present in the laboratory environment, reagents, or apparatus.

Method Detection Limit (MDL) - The minimum concentration of an analyte confirmed by qualitative identification of the analyte(s) in a QC sample in each quality system matrix containing the analyte at no more than 2-3X the MDL for a single analyte tests and 1-4X the MDL for multiple analyte tests that can be identified, measured, and reported with 99% confidence that the analyte concentration is greater than zero but less than the reporting limit (RL). See method SOP for further qualifications.

ReportingLimit (RL): The lowest concentration that can be reliably achieved within specified limits of precision and accuracy during routine laboratory operating conditions. For many analytes the RL analyte concentration is selected as the lowest non-zero standard in the calibration curve.

Solid Sample - For the purpose of this method, a sample taken from material classified as either soil, sediment or sludge.

Water Sample - For the purpose of this method, a sample taken from one of the following sources: drinking, surface, ground, storm runoff, industrial or domestic wastewater.

Quality Assurance Manual

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Quality Assurance Manual
Approval Signatures

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25.6	Client Confidentiality	V1M2 Secs. 4.1.5; 5.10.7	4.1.5; 5.10.7	113
25.7	Format Of Reports	V1M2 Sec. 5.10.8	5.10.8	113
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REFERENCED CORPORATE SOPs AND POLICIES

SOP / Policy Reference	Title
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
CW-Q-S-001	Corporate Document Control and Archiving
CW-Q-S-002	Writing a Standard Operating Procedure (SOPs)
CW-L-S-002	Internal Investigation of Potential Data Discrepancies and Determination for Data Recall
CA-L-S-002	Subcontracting Procedures
CW-L-P-004	Ethics Policy
CA-L-P-002	Contract Compliance Policy
CW-F-P-002	Authorization Matrix
CW-F-P-004	Procurement and Contracts Policy
CA-C-S-001	Work Sharing Process
CA-T-P-001	Qualified Products List
CW-F-S-007	Controlled Purchases Policy
CW-F-S-018	Vendor Selection
CA-Q-M-002	Corporate Quality Management Plan
CW-E-M-001	Corporate Environmental Health & Safety Manual

REFERENCED LABORATORY SOPs

SOP Reference	Title
BR-QA-003	Document Control
BR-QA-004	Complaint Resolution
BR-QA-011	Employee Training and Demonstration of Proficiency
BR-QA-005	Detection Limits, Limit of Detection and Limit of Quantitation
BR-QA-006	Manual Integration
BR-QA-020	Sample Homognenization and Subsampling
BR-SM-001	Sample Management

SECTION 3. INTRODUCTION, SCOPE AND APPLICABILITY

3.1 Introduction and Compliance References

TestAmerica Burlington's Quality Assurance Manual (QAM) is a document prepared to define the overall policies, organization 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.

The QAM has been prepared to assure compliance with The NELAC Institute (TNI) Standard, dated 2009, Volume 1 Modules 2 and 4, and ISO/IEC Guide 17025:2005(E). In addition, the policies and procedures outlined in this manual are compliant with TestAmerica's Corporate Quality Management Plan (CQMP) and the various accreditation and certification programs listed in Appendix 3. 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 QAM has been prepared to be consistent with the requirements of the following documents:

- EPA 600/4-88/039, *Methods for the Determination of Organic Compounds in Drinking Water,* EPA, Revised July 1991.
- EPA 600/R-95/131, *Methods for the Determination of Organic Compounds in Drinking Water,* Supplement III, EPA, August 1995.
- EPA 600/4-79-019, *Handbook for Analytical Quality Control in Water and Wastewater Laboratories,* EPA, March 1979.
- *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.*
- *U.S. Department of Defense, Quality Systems Manual for Environmental Laboratories, Version 4.2, October 2010.*
- Federal Register, 40 CFR Parts 136, 141, 172, 173, 178, 179 and 261.
- *Manual for the Certification of Laboratories Analyzing Drinking Water (EPA 815-R-05-004, January 2005) (DW labs only)*
- APHA, *Standard Methods for the Examination of Water and Wastewater,* 18th Edition, 19th, 20th~~,~~ 21st, and on-line Editions.
- *U.S. Department of Energy* Order 414.1B, *Quality Assurance*, Approved April 29, 2004.
- *U.S. Department of Energy* Order 414.1C, *Quality Assurance*, June 17, 2005.
- *U.S. Department of Energy*, *Quality Systems for Analytical Services*, Revision 3.6, November 2010.
- U.S. Department of Defense, *Air Force Center for Environmental Excellence Quality Assurance Project Plan (QAPP),* Version 4.0.02, May 2006.
- Nuclear Regulatory Commission (NRC) Quality Assurance Requirements.
- Marine Protection, Research, and Sanctuaries Act (MPRSA).
- Toxic Substances Control Act (TSCA).

3.2 Terms and Definitions

A Quality Assurance Program is a company-wide system designed to ensure that 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.

Refer to Appendix 2 for the Glossary/Acronyms.

3.3 Scope / Fields of Testing

The laboratory analyzes a broad range of environmental and industrial samples every month. Sample matrices vary among air, drinking water, effluent water, groundwater, hazardous waste, sludge, soils, sediments, tissue and other biological matrices. 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.

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 performed by the laboratory can be found on the company's data portal, Total Access, or from a representative of the laboratory. 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 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. In these cases, the laboratory will abide by the requested criteria following review and acceptance of the requirements by the Laboratory Director and the Quality Assurance (QA) Manager. In some cases, QAPPs and DQOs may specify less stringent requirements. The Laboratory Director and the QA Manager must determine if it is in the lab's best interest to follow the less stringent requirements.

3.4 Management of the Manual

3.4.1 Review Process

The template on which this manual is based is reviewed annually by Corporate Quality Management Personnel to assure that it remains in compliance with Section 3.1. The 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 will review the changes in the normal course of business and incorporate changes into revised sections of the document. All updates will be reviewed and approved by the senior laboratory management staff according to the laboratory's Document Control procedure (SOP No. BR-QA-003).

SECTION 4. MANAGEMENT REQUIREMENTS

4.1 Overview

TestAmerica Burlington 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., President, Chief Operating Officer, Corporate Quality etc.). The laboratory operational and support staff work under the direction of the Laboratory Director. The organizational structure for both Corporate & TestAmerica Burlington is presented in Figure 4-1.

4.2 Roles and Responsibilities

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.

4.2.1 Additional Requirements for Laboratories

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 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 Burlington laboratory.

4.2.2 Quality Assurance (QA) Manager or Designee

The QA Manager has responsibility and authority to ensure the continuous implementation of the quality system.

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 QA staff to accomplish specific responsibilities, which include, but are not limited to:

- Serves as the focal point for QA/QC in the laboratory.
- Having functions independent from laboratory operations for which he/she has quality assurance oversight.
- Maintaining and updating the QAM.
- Monitoring and evaluating laboratory certifications; scheduling proficiency testing samples.

- Monitoring and communicating regulatory changes that may affect the laboratory to management.
- Training and advising the laboratory staff on quality assurance/quality control procedures that are pertinent to their daily activities.
- Have documented training and/or experience in QA/QC procedures and the laboratory's Quality System.
- 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).
- Arranging for or conducting internal audits on quality systems and the technical operation.
- The laboratory QA Manager will maintain records of all ethics-related training, including the type and proof of attendance.
- Maintain, improve, and evaluate the corrective action database and the corrective and preventive action systems.
- 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 QAM or laboratory SOPs shall be investigated following procedures outlined in Section 12 and if deemed necessary may be temporarily suspended during the investigation.
- Objectively monitor standards of performance in quality control and quality assurance without outside (e.g., managerial) influence.
- Coordinating of document control of SOPs, MDLs, control limits, and miscellaneous forms and information.
- Review 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, sensibility and completeness of the project file contents.
- Review of external audit reports and data validation requests.
- Follow-up with audits to ensure client QAPP requirements are met.
- Establishment of reporting schedule and preparation of various quality reports for the Laboratory Director, clients and/or Corporate QA.
- Development of suggestions and recommendations to improve quality systems.
- Research of current state and federal requirements and guidelines.
- Captains the QA team to enable communication and to distribute duties and responsibilities.
- Ensuring Communication & monitoring standards of performance to ensure that systems are in place to produce the level of quality as defined in this document.
- 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 QAM or laboratory SOPs are temporarily suspended following the procedures outlined in Section 12.
- Evaluation of the thoroughness and effectiveness of training.
- Compliance with ISO 17025. (where applicable)

4.2.3 Technology Manager (AKA Technical Director) & Department Manager (DM)

The Technology Manager report(s) directly to the Laboratory Director. The Technology Manager along with the Laboratory Director, the QA Manager and each Department Manager is accountable for compliance with the ISO 17025 Standard. The Technology Manager works with QA and the Department Managers 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.

The Department Managers report to the Laboratory Directory. The DMs maintain overall responsibility for a defined portion of the laboratory. These responsibilities include but are not limited to:

- 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 performs subsequent analyst training and interpretation of the SOPs for implementation and unusual project samples.
- Reviews and approves proposals from marketing, in accordance with the established procedure for the review of requests and contracts.
- Monitoring the validity of the analyses performed and data generated in the laboratory.
- Providing training and development programs to applicable laboratory staff as new hires and, subsequently, on a scheduled basis. Training includes instruction on calculations, instrumentation management to include troubleshooting and preventive maintenance.
- Enhancing efficiency and improving quality through technical advances and improved LIMS utilization. Capital forecasting and instrument life cycle planning for second generation methods and instruments as well as asset inventory management.
- Working with the QA Manager to scheduling all QA/QC-related requirements for compliance, e.g., MDLs, etc.
- Captains department personnel to communicate quality, technical, personnel, and instrumental issues for a consistent team approach.

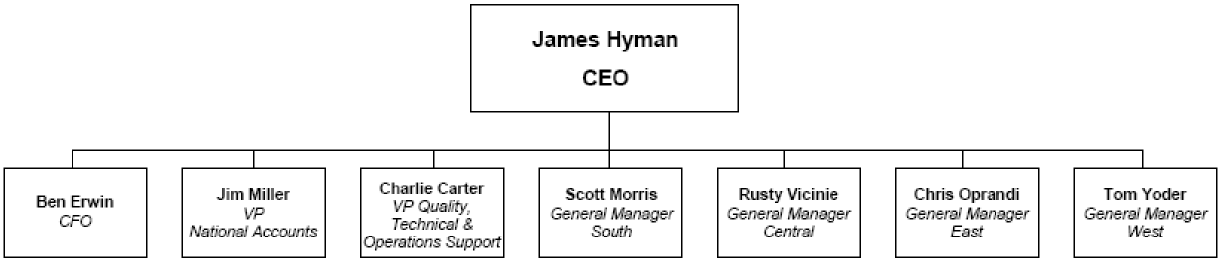
4.3 Deputies

The following table defines who assumes the responsibilities of key personnel in their absence:

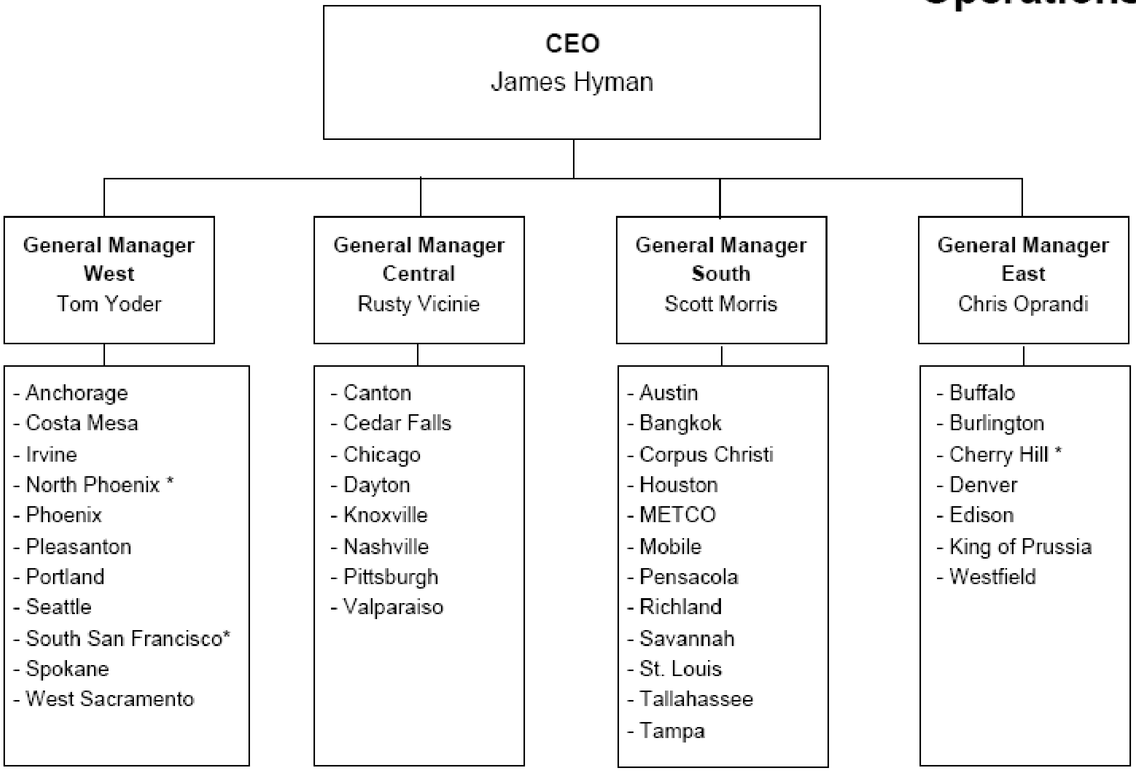
Key Personnel	Deputy
Kirstin L. Daigle Laboratory Director	Brad Chirgwin, Technology Manager Sara S. Goff, QA Manager
Sara S. Goff QA Manager	Kirstin L. Daigle, Laboratory Director Brad Chirgwin, Technology Manager Bonnie Morgan, QA Assistant
Brad Chirgwin Technology Manager	Kirstin L. Daigle, Laboratory Director Sara S. Goff, QA Manager
Dan E. Helfrich EHS Coordinator	Kirstin L. Daigle, Laboratory Director

Figure 4-1. **Corporate and Laboratory Organization Charts**

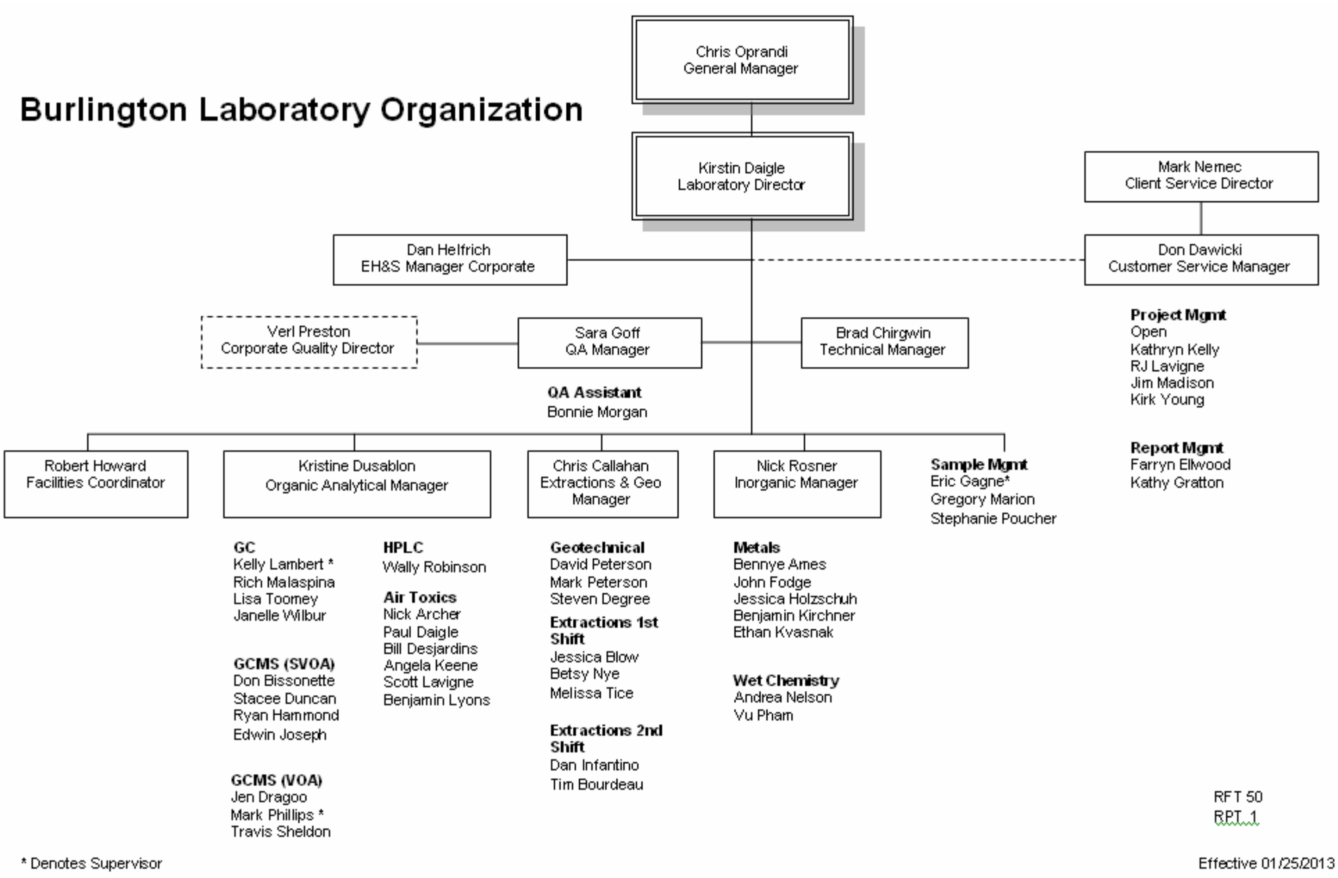
Executive Committee



Operations



* Note: EMLab P&K microlabs report to these facilities.



SECTION 5. QUALITY SYSTEM

5.1 Quality Policy Statement

It is TestAmerica's Policy to:

- Provide data of known quality to its clients by adhering to approved methodologies, regulatory requirements and the QA/QC protocols.

- Effectively manage all aspects of the laboratory and business operations by the highest ethical standards.

- Continually improve systems and provide support to quality improvement efforts in laboratory, administrative and managerial activities. TestAmerica recognizes that the implementation of a quality assurance program requires management's commitment and support as well as the involvement of the entire staff.

- Provide clients with the highest level of professionalism and the best service practices in the industry.

- To comply with the ISO/IEC 17025:2005(E) International Standard, the 2009 TNI Standard and to continually improve the effectiveness of the management system.

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.

5.2 Ethics and Data Integrity

TestAmerica is committed to ensuring the integrity of its data and meeting the quality needs of its clients. The elements of TestAmerica's Ethics and Data Integrity Program include:

- An Ethics Policy (Corporate Policy No. CW-L-P-004) and Employee Ethics Statements.
- Ethics and Compliance Officers (ECOs).
- A Training Program.
- Self-governance through disciplinary action for violations.
- A Confidential mechanism for anonymously reporting alleged misconduct and a means for conducting internal investigations of all alleged misconduct. (Corporate SOP No. CW-L-S-002)
- Procedures and guidance for recalling data if necessary (Corporate SOP No. CW-L-S-002).
- Effective external and internal monitoring system that includes procedures for internal audits (Section 15).
- Produce results, which are accurate and include QA/QC information that meets client pre-defined Data Quality Objectives (DQOs).
- Present services in a confidential, honest and forthright manner.
- Provide employees with guidelines and an understanding of the Ethical and Quality Standards of our Industry.
- Operate our facilities in a manner that protects the environment and the health and safety of employees and the public.
- Obey all pertinent federal, state and local laws and regulations and encourage other members of our industry to do the same.
- Educate clients as to the extent and kinds of services available.
- Assert competency only for work for which adequate personnel and equipment are available and for which adequate preparation has been made.
- Promote the status of environmental laboratories, their employees, and the value of services rendered by them.

5.3 Quality System Documentation

The laboratory's Quality System is communicated through a variety of documents.

- Quality Assurance Manual – Each laboratory has a lab-specific quality assurance manual.

- 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.
- 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).
- Laboratory SOPs – General and Technical
- Laboratory QA/QC Policy Memorandums

5.3.1 Order of Precedence

In the event of a conflict or discrepancy between policies, the order of precedence is as follows:

- Corporate Quality Management Plan (CQMP)
- Corporate SOPs and Policies
- Laboratory QA/QC Policy Memorandum
- Laboratory Quality Assurance Manual (QAM)
- Laboratory SOPs and Policies
- 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 QAM shall take precedence over the CQMP in those cases.

5.4 QA/QC Objectives for the Measurement of Data

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. Quality Assurance is generally understood to be more comprehensive than Quality Control. Quality Assurance can be defined as the integrated system of activities that ensures that a product or service meets defined standards.

Quality Control 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.

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 in order to ensure that analytical services closely correspond to client needs. The client is responsible for developing their project QAPPs. The laboratory will provide support to the client for developing the sections of the QAPP that concern laboratory activities. In order to ensure the ability of the laboratory to meet the Data Quality Objectives (DQOs) specified in the QAPP, clients are advised to allow time for the laboratory to review the QAPP before it is finalized.

Historically, laboratories have described their QC objectives in terms of precision, accuracy, representativeness, comparability, completeness, selectivity and sensitivity (PARCCSS).

5.4.1 Precision

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) duplicate samples.

5.4.2 Accuracy

The laboratory objective for accuracy is to meet the performance for accuracy demonstrated for the methods on similar samples and to meet data quality objectives 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 acceptance recovery about the mean recovery.

5.4.3 Representativeness

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 between separately procured, but otherwise identical samples or sample aliquots.

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.

5.4.4 Comparability

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 laboratory over time.

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.

5.4.5 Completeness

The completeness objective for data as specified for a particular project, is 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 will 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.

5.4.6 Selectivity

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), interelement 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..

5.4.7 Sensitivity

Sensitivity refers to the amount of analyte necessary to produce a detector response that can be reliably detected (Detection Limit, Limit of Detection) or quantified (Limit of Quantiation or Reporting Limit).

5.5 Criteria for Quality Indicators

The laboratory limits used for quality control are stored in the LIMS database (TALS) and may also be published in laboratory SOPs. Limits for accuracy and precision are laboratory generated or are derived from US EPA methods when they are required. Where US EPA method limits are not required, the laboratory has developed limits from evaluation of data from similar matrices. The laboratory procedure for establishment of control limits is described in laboratory SOP BR-QA-013.

5.6 Statistical Quality Control

Statistically-derived precision and accuracy limits are required by selected methods (such as SW-846) and by program. The laboratory routinely utilizes statistically-derived limits to evaluate method performance and determine when corrective action is appropriate. If a method requires the generation of limits from historical data the lab develops such limits from data stored in the LIMS database following the procedure specified in laboratory SOP BR-QA-013.

For each job analysts are instructed to use the current limits that are entered as reference data data in the Laboratory Information Management System (LIMS)   On occasion, a client requests contract-specified limits for a specific project in which case project specific limits are entered into each LIMS job by the PM handling the project.

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. The analyst then evaluates if 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.

5.6.1 QC Charts

The laboratory's procedures for the creation of control charts are described in laboratory SOP BR-QA-013. 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.

5.7 Quality System Metrics

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.

SECTION 6. DOCUMENT CONTROL

6.1 Overview

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:

- Laboratory Quality Assurance Manual
- Laboratory Standard Operating Procedures (SOP)
- Laboratory Policies
- Work Instructions and Forms
- Corporate Policies and Procedures distributed outside the intranet

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 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 No. CW-Q-S-001, Corporate Document Control and Archiving. The laboratory's internal document control procedure is defined in SOP BR-QA-003.

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. Instrument manuals (hard or electronic copies) are also maintained by the laboratory.

The laboratory records for supporting records such as audit reports and responses, logbooks, standard logs, training files, MDL studies, Proficiency Testing (PT) studies, certifications and related correspondence, and corrective action reports are kept by the QA department. Raw analytical data consists of bound logbooks, instrument printouts, any other notes, magnetic media, electronic data and final reports are retained electronically, by each analytical section or by the QA department.

6.2 Document Approval and Issue

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 or an 'end of document' page, the effective date, revision number and the laboratory's name. The QA personnel are responsible for the maintenance of this system.

Controlled documents are authorized by the QA Department. To develop a new document, the department manager or any employee with approval from the department manager submits an draft of the form to the QA Department for approval before use. Upon approval QA personnel add the identifying version information to the document and retains a copy of the document as the official document on file. The document is then provided to all applicable operational units (may include electronic access) by either electronic or hardcopy distribution.

The QA Department maintains a list of the official versions of controlled documents.

Quality System Policies and Procedures will be reviewed annually and revised as appropriate. Changes to documents occur when a procedural change warrants.

6.3 Procedures for Document Control Policy

For changes to the QA Manual, refer to SOP BR-QA-003. Uncontrolled copies must not be used within the laboratory. Previous revisions are stored by the QA department. The current revision is located in the public controlled document folder accessible to all employees.

For changes to SOPs, refer to SOP No. CW-Q-S-002, Writing a Standard Operating Procedure SOP.

Forms, worksheets, work instructions and information are organized by the QA department in accordance with the procedures specified in laboratory SOP BR-QA-003.

6.4 Obsolete Documents

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, 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 according to SOP BR-QA-003.

SECTION 7. SERVICE TO THE CLIENT

7.1 Overview

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.

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.

All projects, proposals and contracts are reviewed for the client's requirements in terms of compound lists, test methodology requested, sensitivity (detection and reporting levels), accuracy, and precision requirements (% Recovery 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.

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 will be checked for feasibility.

Electronic or hard copy deliverable requirements are evaluated against the laboratory's capacity for production of the documentation.

If the laboratory cannot provide all services but intends to subcontract such services, whether to another TestAmerica facility or to an outside firm, this will be documented and discussed with the client prior to contract approval. (Refer to Section 8 for Subcontracting Procedures.)

The laboratory informs the client of the results of the review if it indicates any potential conflict, deficiency, lack of accreditation, or inability of the lab to complete the work satisfactorily. 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.

All contracts, QAPPs, Sampling and Analysis Plans (SAPs), contract amendments, and documented communications become part of the project record.

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

Work requests are reviewed by appropriate personnel at each stage of evaluation.

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.

For new, complex or large projects, the proposed contract is given to the Sales Directors, who will decide which lab will receive the work based on the scope of work and other requirements, including certification, testing methodology, and available capacity to perform the work. The contract review process is outlined in TestAmerica's Corporate SOP No. CA-L-P-002**,** Contract Compliance Policy.

This review encompasses all facets of the operation. The scope of work is distributed to the appropriate personnel, as needed based on scope of contract, to evaluate all of the requirements shown above. Appropriate personnel include but are not limited to:

- Legal & Contracts Director
- General Manager
- Laboratory Director
- Laboratory Project Manager
- Laboratory Technology Manager
- Laboratory Department Manager
- Laboratory Customer Service Manager
- Information Technology Manager
- Account Executives
- Laboratory and/or Corporate Quality Managers
- Laboratory and/or Corporate Environmental Health and Safety Managers/Directors

In the event that one of the above personnel is not available to review the contract, his or her back-up will fulfill the review requirements. The Laboratory Director reviews the formal laboratory quote and makes final acceptance for their facility. The Project Manager, Sales Director, Legal Contracts Director, Account Executive or Proposal Coordinator then submits the final proposal to the client. The Legal & Contracts Director and facility Customer Service Manager maintains copies of all signed contracts.

7.3 Documentation

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. Records of review are organized and kept by the designated project manager (PM).

The contract will be distributed to and maintained by the appropriate sales/marketing personnel and the Account Executive. A copy of the contract and formal quote will be filed with the laboratory PM.

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. These records are retained by the laboratory PM.

7.3.1 Project-Specific Quality Planning

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. 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.

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.

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.

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. Such changes are also communicated to laboratory staff.

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

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 states that a laboratory "shall afford clients or their representatives cooperation to clarify the client's request". This topic is discussed in Section 7.

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:

- Reasonable access for our clients or their representatives to the relevant areas of the laboratory for the witnessing of tests performed for the client.
- Assist client-specified third party data validators as specified in the client's contract.
- 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

Project managers are the primary communication link to the clients. They shall inform their clients of any delays in project completion as well as any non-conformances in either sample receipt or sample analysis. Project management will maintain ongoing client communication throughout the entire client project.

The Technology Manager and the Quality Assurance Manager are available to discuss any technical questions or concerns that the client may have.

7.6 Reporting

The laboratory works with our clients to produce any special communication reports required by the contract.

7.7 Client Surveys

The laboratory assesses both positive and negative client feedback. The results are used to improve overall laboratory quality and client service. TestAmerica's Sales and Marketing teams periodically develops lab and client specific surveys to assess client satisfaction.

SECTION 8. SUBCONTRACTING OF TESTS

8.1 Overview

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.

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 will meet the same commitments we have made to the client. Refer to TestAmerica's Corporate SOP's on Subcontracting Procedures (CA-L-S-002) and the Work Sharing Process (CA-C-S-001).

When outsourcing analytical services, the laboratory will 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 ISO 17025 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 will be placed with an appropriately accredited laboratory. The laboratory performing the subcontracted work will be identified in the final report, as will non-NELAC accredited work where required.

Project Managers (PMs), Customer Service Managers (CSM), or Account Executives (AE) for the Export Lab are responsible for obtaining client approval prior to outsourcing any samples. The laboratory will advise the client of a subcontract or work sharing arrangement in writing and when possible approval from the client shall 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

Whenever a PM, Account Executive (AE) or Customer Service Manager 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:

- The first priority is to attempt to place the work in a qualified TestAmerica laboratory;
- 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);
- 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.
- Firms identified in accordance with the company's Small Business Subcontracting program as small, women-owned, veteran-owned and/or minority-owned businesses;
- NELAC or A2LA accredited laboratories.
- In addition, the firm must hold the appropriate certification to perform the work required.

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. (Corporate SOP No. CA-C-S-001, Work Sharing Process).

When the potential sub-contract laboratory has not been previously approved, management staff 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 No. 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).

8.2.1 Once the appropriate accreditation and legal information is received by the laboratory, it is evaluated for acceptability (where applicable) and forwarded to Corporate Contracts for formal contracting with the laboratory. They will add the lab to the approved list on the intranet site and notify the finance group for JD Edwards.

8.2.2 The client will 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 known 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.

8.2.3 The status and performance of qualified subcontractors will be monitored periodically by the Corporate Contracts and/or Quality Departments. Any problems identified will be brought to the attention of TestAmerica’s Corporate Finance or Corporate Quality personnel.

- Complaints shall be investigated. Documentation of the complaint, investigation and corrective action will be maintained in the subcontractor’s file on the intranet site. Complaints are posted using the Vendor Performance Report.
- Information shall be updated on the intranet when new information is received from the subcontracted laboratories.
- Subcontractors in good standing will be retained on the intranet listing. The QA Manager will notify all TestAmerica laboratories, Corporate Quality and Corporate Contracts if any laboratory requires removal from the intranet site. This notification will be posted on the intranet site and e-mailed to all Laboratory Directors, QA Managers and Sales Personnel.

8.3 Oversight and Reporting

The 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 flow down 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 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.

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 in the project folder. An example form that may be used for documentation is provided as Figure 8-1. For TestAmerica laboratories, certifications can be viewed on the company's TotalAccess Database.

The Sample Control department is responsible for ensuring compliance with QA requirements and applicable shipping regulations when shipping samples to a subcontracted laboratory.

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.

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.

Non-NELAC accredited work must be identified in the subcontractor's report as appropriate. If NELAC accreditation is not required, the report does not need to include this information.

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 laboratories EDD (i.e., imported), the report must explicitly indicate which lab produced the data for which 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

The Laboratory Director may waive the full qualification of a subcontractor process temporarily to meet emergency needs; however, this decision & 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., PM) 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.

Figure 8-1.

Example - Subcontracted Sample Form

Date/Time: ____

Subcontracted Laboratory Information:

- Subcontractor's Name: ____
- Subcontractor Point of Contact: ____
- Subcontractor's Address: ____
- Subcontractor's Phone: ____
- Analyte/Method: ____
- Certified for State of Origin: ____
- NELAC Certified: Yes________________No_________________
- USDA Permit (__Domestic __ Foreign) Yes________________No_________________
- ISO 17025 Certified: Yes________________No_________________
- CLP-like Required: (Full doc required) Yes________________No_________________
- Requested Sample Due Date: (Must be put on COC) ____
- Client POC Approval on-file to Subcontract Samples to Sub Laboratory: Yes________________No_________________

Project Manager: ____

Laboratory Sample # Range: ____
(Only of Subcontracted Samples)

Laboratory Project Number (Billing Control #): ____

All subcontracted samples are to be sent via bonded carrier and Priority Overnight. Please attach tracking number below and maintain these records in the project files.

PM Signature____**Date**____________________________

SECTION 9. PURCHASING SERVICES AND SUPPLIES

9.1 Overview

Evaluation and selection of suppliers and vendors is performed, in part, on the basis of the quality of their products, their ability to meet the demand for their products 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 No. CW-F-S-007.

Contracts will be signed in accordance with TestAmerica's Corporate Authorization Matrix Policy, Policy No. CW-F-P-002. Request for Proposals (RFP's) will be issued where more information is required from the potential vendors than just price. Process details are available in TestAmerica's Corporate Procurement and Contracts Policy (Policy No. 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

Glassware used for volumetric measurements must be Class A or verified for accuracy according to laboratory procedure. Pyrex (or equivalent) glass should be used where possible. For safety purposes, thick-wall glassware should be used where available.

9.3 Reagents, Standards & Supplies

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 & Acid Lot Testing & Approval, SOP No. CA-Q-S-001.

9.3.1 Purchasing

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.

9.3.2 Receiving

It is the responsibility of the manager that placed the order to receive the shipment. It is the responsibility of the manager or their designee who ordered the materials to document the date materials where received. Once the ordered reagents or materials are received the information on the label or packaging to the original order to ensure that the purchase meets the quality level specified. Material Safety Data Sheets (MSDSs) are 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.

9.3.3 Specifications

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.

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 may contact the manufacturer to determine an expiration date.

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 should not be used past the manufacturer's or SOPs expiration date unless 'verified' (refer to item 3 listed below).

- 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.
- 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), Blanks, Laboratory Control Sample (LCS), etc.).
- If the dry chemical/solvent is used for the preparation of standards, the expiration dates can be extended 6 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 each laboratory section.

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.

Compressed gases in use are checked for pressure and secure positioning daily. The minimum total pressure must be 120 psig for Helium, 100 psig for liquid Argon and 30 psig for Nitrogen or the tank must be replaced. To prevent a tank from going to dryness, close observation of the tank gauge must take place as pressure decreases towards the minimum psig, or the tank must be replaced. The quality of the gases must meet method or manufacturer specification or be of a grade that does not cause any analytical interference.

Water used in the preparation of standards or reagents must have a specific conductivity of less than 1- µmhom/cm (or specific resistivity of greater than 1.0 megohm-cm) at 25^{o}C. The specific conductivity is checked and recorded daily. If the water's specific conductivity is greater than the specified limit, the Facility Manager and appropriate Technical Managers must be notified immediately in order to notify all departments, decide on cessation (based on intended use) of activities, and make arrangements for correction.

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.

Standard lots are verified before first time use if the laboratory switches manufacturers or has historically had a problem with the type of standard.

Purchased bottleware used for sampling must be certified clean and the certificates must be maintained. If uncertified sampling bottleware is purchased, all lots must be verified clean prior to use. This verification must be maintained.

Records of manufacturer's certification and traceability statements are maintained in each laboratory section. These records include date of receipt, lot number (when applicable), and expiration date (when applicable). Incorporation of the item into the record indicates that the analyst has compared the new certificate with the previous one for the same purpose and that no difference is noted, unless approved and so documented by the Technology Manager or QA Manager.

9.3.4 Storage

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 (Corp. Doc. No. CW-E-M-001) and method SOPs or manufacturer instructions.

9.4 Purchase of Equipment / Instruments / Software

When a new piece of equipment is needed, either for additional capacity or for replacing inoperable equipment, the analyst or supervisor makes a supply request to the Laboratory Director. If they agree with the request, the procedures outlined in TestAmerica's Corporate Policy No. 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.

Upon receipt of a new or used piece of equipment, an identification name is assigned and added to the equipment list. IT must also be notified so that they can synchronize the instrument for back-ups. 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, Demonstration of Capabilities (DOCs), and other relevant criteria (refer to Section 19). For software, its operation must be deemed reliable and evidence of instrument verification must be retained by IT or the QA Department. Software certificates supplied by the vendors are kept by IT. The manufacturer's operation manual is retained at the bench.

9.5 Services

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 Technical Managers. If an external contractor is selected to perform service, the service providers that perform the services are approved by the Technical Manager.

9.6 Suppliers

TestAmerica selects vendors through a competitive proposal / bid process, strategic business alliances or negotiated vendor partnerships (contracts). This process is defined in the Corporate Finance documents on Vendor Selection (SOP No. CW-F-S-018) and Procurement & Contracts Policy (Policy No. 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.

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.

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.

The Corporate Purchasing Group will work through the appropriate channels to gather the information required to clearly identify the problem and will contact the vendor to report the problem and to make any necessary arrangements for exchange, return authorization, credit, etc.

As deemed appropriate, the Vendor Performance Reports will be summarized and reviewed to determine corrective action necessary, or service improvements required by vendors.

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.

9.6.1 New Vendor Procedure

TestAmerica employees who wish to request the addition of a new vendor must complete a J.D. Edwards Vendor Add Request Form.

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 and/or the Technology Director are consulted with vendor and product selection that have an impact on quality.

SECTION 10. COMPLAINTS

10.1 Overview

The laboratory considers an effective client complaint handling processes 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 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.

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.

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.

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.

The process of complaint resolution and documentation utilizes the procedures outlined in Section 12 (Corrective Actions) and is documented following laboratory SOP BR-QA-004.

10.2 External Complaints

An employee that receives a complaint initiates the complaint resolution process by first documenting the complaint according to laboratory SOP BR-QA-004.

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 should be reviewed for preventive action measures to reduce the likelihood of future occurrence and mitigation of client impact.

The general steps in the complaint handling process are:

- Receiving and Documenting Complaints
- Complaint Investigation and Service Recovery
- Process Improvement

The laboratory shall inform the initiator of the complaint of the results of the investigation and the corrective action taken, if any.

10.3 Internal Complaints

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 shall follow the procedures outlined in Section 12. In addition, Corporate Management, Sales and Marketing and IT may initiate a complaint by contacting the laboratory or through the corrective action system described in Section 12.

10.4 Management Review

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).

SECTION 11. CONTROL OF NON-CONFORMING WORK

11.1 Overview

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).

Due to the frequently unique nature of environmental samples, sometimes departures from documented policies and procedures are needed. Any modifications to the routine procedure are documented in the project record and described in the case narrative submitted with the report.

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. Any project specific modifications to the procedure are documented in the project record.

11.2 Responsibilities and Authorities

TestAmerica's Corporate SOP entitled *Internal Investigation of Potential Data Discrepancies and Determination for Data Recall* (SOP No. CW-L-S-002) outlines the general procedures for the reporting and investigation of data discrepancies and alleged incidents of misconduct or violations of TestAmerica's data integrity policies as well as the policies and procedures related to the determination of the potential need to recall data.

The Laboratory Director, a Technology or Department Manager or a member of the QA team may 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 will be informed of the departure prior to the reporting of the data. Any departures must be documented. Any impacted data must be referenced in a case narrative and/or flagged with an appropriate data qualifier.

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 comprised of the Laboratory Director, the QA Manager, and the Technical Managers. 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 & Client Advocacy and the laboratory's Quality Director within 24 hours of discovery.

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.

The Laboratory Director, QA Manager, ECOs, Corporate Quality, the COO, General Managers and the 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

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.

TestAmerica's Corporate Data Investigation & Recall Procedure (SOP No. CW-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 ECO's 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's Corporate SOP No. CW-L-S-002.

11.4 Prevention of NonConforming Work

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, 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)

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.

Prior to suspension/restriction, confidentiality will be respected, and the problem with the required corrective and preventive action will be stated in writing and presented to the Laboratory Director.

The Laboratory Director shall arrange for the appropriate personnel to meet with the QA Manager as needed. This meeting shall be held to confirm that there is a problem, that suspension/restriction of the method is required and will 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.

The QA Manager will 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.

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 (e.g., Project Management, Log-in, etc…). Clients will NOT generally be notified at this time. Analysis may proceed in some instances depending on the non-conformance issue.

Within 72 hours, the QA Manager will 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, Technology Manager, QA Manager) 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.

SECTION 12. CORRECTIVE ACTION

12.1 Overview

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. Corrective actions are documented using Non-Conformance Reports (NCR) and Corrective Action Reports (CAR) (refer to Figure 12-1).

12.2 General

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, proficiency testing (PT) performance, client complaints, staff observation, etc..

The purpose of a corrective action system is to:

- Identify non-conformance events and assign responsibility(s) for investigating.
- Resolve non-conformance events and assign responsibility for any required corrective action.
- Identify systematic problems before they become serious.
- Identify and track client complaints and provide resolution.

12.2.1 **Non-Conformance Report (NCR)** - is used to document the following types of corrective actions:

- Deviations from an established procedure or SOP
- QC outside of limits (non-matrix related)
- Isolated reporting / calculation errors
- Client complaints
- Discrepancies in materials / goods received vs. manufacturer packing slips.

12.2.2 **Corrective Action Report (CAR)** - is used to document the following types of corrective actions:

- Questionable trends that are found in the review of NCRs.
- Issues found while reviewing NCRs that warrant further investigation.
- Failed or unacceptable PT results.
- Corrective actions that cross multiple departments in the laboratory.
- Systematic reporting / calculation errors
- Client complaints
- Data recall investigations
- Identified poor process or method performance trends
- Excessive revised reports

This will provide background documentation to enable root cause analysis and preventive action.

12.3 Closed Loop Corrective Action Process

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.

12.3.1 Cause Analysis

- Upon discovery of a non-conformance event, the event must be defined and documented. An NCM or CAR 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.
- The cause analysis step is the key to the process as a long term corrective action cannot be determined until the cause is determined.
- If the cause is not readily obvious, the Technology Manager and/or Department Manager, Laboratory Director, or QA Manager (or QA designee) is consulted.

12.3.2 Selection and Implementation of Corrective Actions

- Where corrective action is needed, the laboratory shall 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.
- Corrective actions shall be to a degree appropriate to the magnitude of the problem identified through the cause analysis.
- Whatever corrective action is determined to be appropriate, the laboratory shall document and implement the changes. The NCM or CAR is used for this documentation.

12.3.3 Root Cause Analysis

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.

To perform root cause analysis, systematically analyze and document the root causes of the more significant problems reported then 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.

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 5 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.

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.

12.3.4 Monitoring of the Corrective Actions

- The Technology Manager and/or Department Manager and QA Manager are responsible to ensure that the corrective action taken was effective.
- Ineffective actions are documented and re-evaluated until acceptable resolution is achieved. Technical Managers are accountable to the Laboratory Director to ensure final acceptable resolution is achieved and documented appropriately.
- Corrective actions are tracked by the QA department.
- The QA Manager reviews NCMs and CARs monthly 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.
- 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.

12.3.5 Follow-up Audits

- Follow-up audits may be initiated by the QA Manager and shall 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.
- 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 15.1.4, Special Audits.)

12.4 Technical Corrective Actions

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). The documentation of these procedures is through the use of an NCM or CAR.

Table 12-1 includes examples of general technical corrective actions. For specific criteria and corrective actions, refer to specific method SOPs.

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, QAM Sections 19 and 20. All corrective actions are reviewed monthly, at a minimum, by the QA Manager and highlights are included in the QA monthly report.

To the extent possible, samples shall be reported only if all quality control measures are acceptable. If the deficiency does not impair the usability of the results, data will be reported with an appropriate data qualifier and/or the deficiency will be noted in the case narrative. Where sample results may be impaired, the Project Manager is notified by an NCM and appropriate corrective action (e.g., reanalysis) is taken and documented**.**

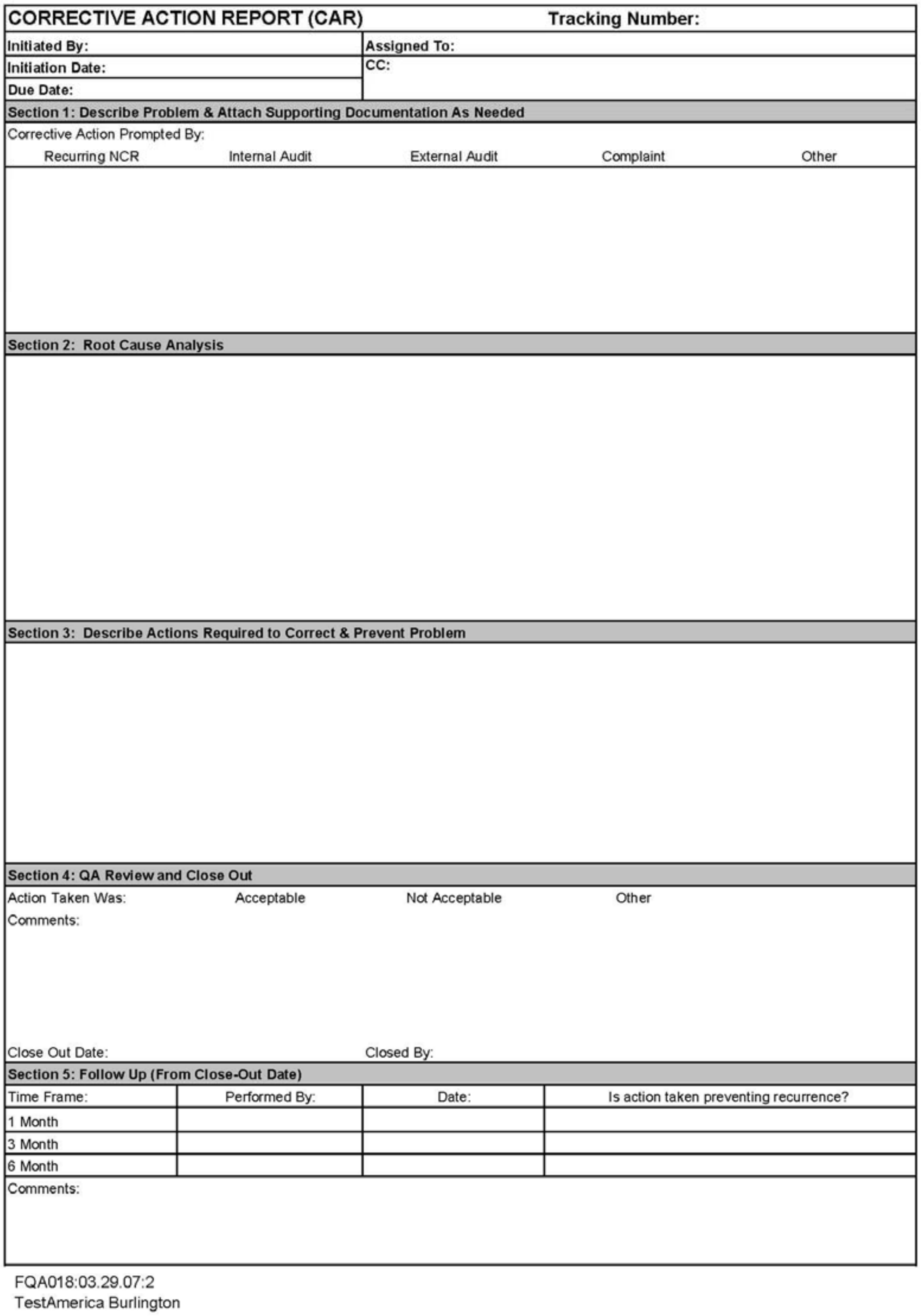
12.5 Basic Corrections

When mistakes occur in records, each mistake shall be crossed-out, [not obliterated (e.g. no white-out)], and the correct value entered alongside. All such corrections shall 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.

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.

When corrections are due to reasons other than obvious transcription errors, the reason for the corrections (or additions) shall also be documented.

Figure 12-1.
Example - Corrective Action Report



CORRECTIVE ACTION REPORT (CAR) **Tracking Number:**

Initiated By:	**Assigned To:**
Initiation Date:	**CC:**
Due Date:	

Section 1: Describe Problem & Attach Supporting Documentation As Needed

Corrective Action Prompted By:

Recurring NCR Internal Audit External Audit Complaint Other

Section 2: Root Cause Analysis

Section 3: Describe Actions Required to Correct & Prevent Problem

Section 4: QA Review and Close Out

Action Taken Was: Acceptable Not Acceptable Other

Comments:

Close Out Date: Closed By:

Section 5: Follow Up (From Close-Out Date)

Time Frame:	Performed By:	Date:	Is action taken preventing recurrence?
1 Month			
3 Month			
6 Month			

Comments:

FQA018:03.29.07:2
TestAmerica Burlington

Table 12-1. Example – General Corrective Action Procedures

QC Activity ***(Individual Responsible for Initiation/Assessment)***	**Acceptance Criteria**	**Recommended Corrective Action**
Initial Instrument Blank (Analyst)	See details in Method SOP	- Prepare another blank. - If same response, determine cause of contamination: reagents, environment, instrument equipment failure, etc.
Initial Calibration Standards (Analyst)	See details in Method SOP	- Reanalyze standards. - If still unacceptable, remake standards and recalibrate instrument.
Independent Calibration Verification (Second Source) (Analyst)	% Recovery within limits in TALS	- Remake and reanalyze standard. - If still unacceptable, then remake calibration standards or use new primary standards and recalibrate instrument.
Continuing Calibration Standards (Analyst)	- See details in Method SOP	- Reanalyze standard. - If still unacceptable, then recalibrate and rerun affected samples.
Matrix Spike / Matrix Spike Duplicate (MS/MSD) (Analyst)	% Recovery within limits in TALS	- If the acceptance criteria for duplicates or matrix spikes are not met because of matrix interferences, the acceptance of the analytical batch is determined by the validity of the LCS. - If the LCS is within acceptable limits the batch is acceptable. - The results of the duplicates, matrix spikes and the LCS are reported with the data set. - For matrix spike or duplicate results outside criteria the data for that sample shall be reported with qualifiers.

QC Activity *(Individual Responsible for Initiation/Assessment)*	**Acceptance Criteria**	**Recommended Corrective Action**
Laboratory Control Sample (LCS) (Analyst)	% Recovery within limits in TALS	- Batch must be re-prepared and re-analyzed. This includes any allowable marginal exceedance. When not using marginal exceedances, the following exceptions apply: 1) when the acceptance criteria for the positive control are exceeded high (i.e., high bias) and there are associated samples that are non-detects, then those non-detects may be reported with data qualifying codes; 2) when the acceptance criteria for the positive control are exceeded low (i.e., low bias), those sample results may be reported if they exceed a maximum regulatory limit/decision level with data qualifying codes. **Note:** If there is insufficient sample or the holding time cannot be met, contact client and report with flags.
Surrogates (Analyst)	- % Recovery within limits in TALS.	- Individual sample must be repeated. Place comment in LIMS. - Surrogate results outside criteria shall be reported with qualifiers.
Method Blank (MB) (Analyst)	< Reporting Limit or as specified by regulatory program.	- Reanalyze blank. - If still positive, determine source of contamination. If necessary, reprocess (i.e. digest or extract) entire sample batch. Report blank results. - Qualify the result(s) if the concentration of a targeted analyte in the MB is at or above the reporting limit AND is > 1/10 of the amount measured in the sample.
Proficiency Testing (PT) Samples (QA Manager, Department Manager(s)	- Criteria supplied by PT Supplier.	- Any failures or warnings must be investigated for cause. Failures may result in the need to repeat a PT sample to show the problem is corrected.

QC Activity ***(Individual Responsible for Initiation/Assessment)***	**Acceptance Criteria**	**Recommended Corrective Action**
Internal / External Audits (QA Manager, Technology Manager and Department Manager(s), Laboratory Director)	- Defined in Quality System documentation such as SOPs, QAM, etc..	- Non-conformances must be investigated through CAR system and necessary corrections must be made.
Reporting / Calculation Errors (Depends on issue – possible individuals include: Analysts, Data Reviewers, Project Managers, Technical Managers, QA Manager, Corporate QA, Corporate Management)	- SOP CW-L-S-002Internal Investigation of Potential Data Discrepancies and Determination for Data Recall.	- Corrective action is determined by type of error. Follow the procedures in SOP CW-L-S-002 or your lab's CA SOP.
Client Complaints (Project Managers, Lab Director/Manager, Sales and Marketing)	-	- Corrective action is determined by the type of complaint. For example, a complaint regarding an incorrect address on a report will result in the report being corrected and then follow-up must be performed on the reasons the address was incorrect (e.g., database needs to be updated).
QA Monthly Report (Refer to Section 16 for an example) (QA Manager, Lab Director)	- QAM, SOPs.	- Corrective action is determined by the type of issue. For example, CARs for the month are reviewed and possible trends are investigated.
Health and Safety Violation (Safety Officer, Lab Director)	- Environmental Health and Safety (EHS) Manual.	- Non-conformance is investigated and corrected through CAR system.

SECTION 13. PREVENTIVE ACTION / IMPROVEMENT

13.1 Overview

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 that the preventive action process is in place, and that relevant information on actions is submitted for management review.

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.

Opportunities for improvement may be discovered during management reviews, the monthly QA Metrics Report, evaluation of internal or external audits, results & evaluation of proficiency testing (PT) performance, data analysis & review processing operations, client complaints, staff observation, etc.

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.

The laboratory's corrective action process 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.

13.1.1 The following elements are part of a preventive action system:

- Identification of an opportunity for preventive action.
- Process for the preventive action.
- Define the measurements of the effectiveness of the process once undertaken.
- Execution of the preventive action.
- Evaluation of the plan using the defined measurements.
- Verification of the effectiveness of the preventive action.
- 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.

13.1.2 Any Preventive Actions undertaken or attempted shall be taken into account during the annual Management Systems Review (Section 16). A highly detailed report is not required; however, a summary of successes and failures within the preventive action program is sufficient to provide management with a measurement for evaluation.

13.2 Management of Change

The Management of Change process is designed to manage significant events and changes that occur within the laboratory such as the addition of new equipment or personnel. Procedures for minimization of potential risks inherent with a new event or change are described in various laboratory standard operating procedures.

SECTION 14. CONTROL OF RECORDS

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.

14.1 Overview

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. Records are of two types; 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 each laboratory section.

Table 14-1. Record Index[1]

	Record Types [1]**:**	**Retention Time:**
Technical Records	- Raw Data - Logbooks[2] - 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*

	Record Types [1]:	**Retention Time:**
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)	7 Years (HR Personnel Files must be maintained indefinitely)
	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.

14.1.1 All records are stored and retained in such a way that they are secure and readily retrievable at the laboratory facility or an offsite location that provides a suitable environment to prevent damage or deterioration and to prevent loss**.** All records shall be protected against fire, theft, loss, environmental deterioration, and vermin. In the case of electronic records, electronic or magnetic sources, storage media are protected from deterioration caused by magnetic fields and/or electronic deterioration.

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.

For raw data and project records, record retention shall 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.

14.1.2 Programs with Longer Retention Requirements

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.

Table 14-2. Example: Special Record Retention Requirements

Program	[1]Retention Requirement
Drinking Water – All States	**5 years (project records)** **10 years - Radiochemistry (project records)**
Drinking Water Lead and Copper Rule	12 years (project records)
Commonwealth of MA – All environmental data 310 CMR 42.14	10 years
FIFRA – 40 CFR Part 160	Retain for life of research or marketing permit for pesticides regulated by EPA
Housing and Urban Development (HUD) Environmental Lead Testing	10 years
Alaska	10 years
Louisiana – All	10 years
Michigan Department of Environmental Quality – all environmental data	10 years
Navy Facilities Engineering Service Center (NFESC)	10 years
NY Potable Water NYCRR Part 55-2	10 years
Ohio VAP	10 years and State contacted prior to disposal
TSCA - 40 CFR Part 792	10 years after publication of final test rule or negotiated test agreement

[1] Note: Extended retention requirements must be noted with the archive documents or addressed in facility-specific records retention procedures.

14.1.3 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 hard copy 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.

14.1.4 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. The history of the sample from when the laboratory took possession of the samples must be readily understood through the documentation. This shall include inter-laboratory transfers of samples and/or extracts.

- 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.

- 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.

- The record keeping system facilitates the retrieval of all working files and archived records for inspection and verification purpose. Instrument data is stored by instrument. Run logs are maintained for each instrument. 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 recorded in logbooks or entered into the LIMS for each method as required.

- Changes to hardcopy records shall follow the procedures outlined in Section 12 and 19. Changes to electronic records in LIMS or instrument data are recorded in audit trails.

- 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”.

- All generated data except those that are generated by automated data collection systems, are recorded directly, promptly and legibly in permanent dark ink.

- 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 that 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 that was scanned.

- Also refer to Section 19.14.1 ‘Computer and Electronic Data Related Requirements’**.**

14.2 Technical and Analytical Records

14.2.1 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. The records for each analysis shall contain sufficient information to enable the analysis to be repeated under conditions as close as possible to the original.

14.2.2 Observations, data and calculations are recorded real-time and are identifiable to the specific task.

14.2.3 Changes to hardcopy records shall follow the procedures outlined in Section 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:

- laboratory sample ID code**;**
- Date of analysis; Time of Analysis is also required if the holding time is seventy-two (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 in a specific logbook or on a benchsheet.

- Instrumentation identification and instrument operating conditions/parameters.
- analysis type;
- all manual calculations and manual integrations;
- analyst's or operator's initials/signature;
- sample preparation
- test results;
- standard and reagent origin, receipt, preparation, and use;
- calibration criteria, frequency and acceptance criteria;
- data and statistical calculations, review, confirmation, interpretation, assessment and reporting conventions;
- quality control protocols and assessment;
- electronic data security, software documentation and verification, software and hardware audits, backups, and records of any changes to automated data entries; and
- Method performance criteria including expected quality control requirements.

14.3 Laboratory Support Activities

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):

- 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);
- 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;
- copies of final reports;
- archived SOPs;
- correspondence relating to laboratory activities for a specific project;
- all corrective action reports, audits and audit responses;
- proficiency test results and raw data; and
- results of data review, verification, and crosschecking procedures

14.3.1 Sample Handling Records

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:

- sample preservation including appropriateness of sample container and compliance with holding time requirement;
- sample identification, receipt, acceptance or rejection and login;
- sample storage and tracking including shipping receipts, sample transmittal / COC forms; and
- procedures for the receipt and retention of samples, including all provisions necessary to protect the integrity of samples.

14.4 Administrative Records

The laboratory also maintains the administrative records in either electronic or hard copy form. Refer to Table 14-1.

14.5 Records Management, Storage and Disposal

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 upon request.

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.

Records that are stored or generated by computers or personal computers have hard copy, write-protected backup copies, or an electronic audit trail controlling access**.**

The laboratory has a record management system (a.k.a., document control) for control of laboratory notebooks, instrument logbooks, standards logbooks, and records for data reduction, validation, storage and reporting. The procedures for document are described in laboratory SOP BR-QA-003.

14.5.1 Transfer of Ownership

In the event that 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 5 years of such action.

14.5.2 Records Disposal

Records are removed from the archive and destroyed after 5 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).

Electronic copies of records must be destroyed by erasure or physically damaging off-line storage media so no records can be read.

If a third party records management company is hired to dispose of records, a “Certificate of Destruction” is required.

SECTION 15. AUDITS

15.1 Internal Audits

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.

Audits are conducted and documented as described in the TestAmerica Corporate SOP on performing Internal Auditing, SOP No. CA-Q-S-004. 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: a) QA Manager or designee b) Technology Manager or Designee (Refer to CA-Q-S-004)	Methods Audits Frequency: 50% of methods annually 100% of methods 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	Two successful per year for each TNI field of proficiency testing or as dictated by regulatory requirements

15.1.1 Annual Quality Systems Audit

An annual quality systems audit is required to ensure compliance to analytical methods and SOPs, TestAmerica's Data Integrity and Ethics Policies, the TNI quality systems requirements, 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 actions is assessed for effectiveness & 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.

15.1.2 QA Technical Audits

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., MintMiner and Chrom AuditMiner) used to identify unusual manipulations of the data deserving closer scrutiny. QA technical audits will include all methods within a two-year period.

15.1.3 SOP Method Compliance

Compliance of all SOPs with the source methods and compliance of the operational groups with the SOPs will be assessed by the Quality Assurance Manager or qualified designee at least every two years.

15.1.4 Special Audits

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.

15.1.5 Performance Testing

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: water, soil, air.

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.

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.

15.2 External Audits

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 supervisors 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 labs corrective action plan will be forwarded to Corporate Quality.

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.

15.2.1 Confidential Business Information (CBI) Considerations

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.

15.3 Audit Findings

Audit findings are documented in audit reports and tracked by the QA department. The laboratory's corrective action responses for internal and external audits include action plans and date for completion. If a completion date cannot be met, a new a completion date must be set and agreed to by the QA Manager.

Developing and implementing corrective actions 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 labs corrective action plan will be forwarded to Corporate Quality.

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 shall take timely corrective action, and shall 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.

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.

SECTION 16. MANAGEMENT REVIEWS

16.1 Quality Assurance Report

A comprehensive QA Report shall be prepared each month by the laboratory's QA Department and forwarded to the Laboratory Director, their Quality Director as well as the General Manager. 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, General Manager or Corporate QA may request that additional information be added to the report.

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

The senior lab management team (Laboratory Director, Technology Manager, Department Manager and QA 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. 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 will summarize any critical findings that can not be solved by the lab and report them to Corporate IT.

This management systems review (Corporate SOP No. CA-Q-S-008 & Work Instruction No. CA-Q-WI-020) 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:

- Matters arising from the previous annual review.
- Prior Monthly QA Reports issues.
- Laboratory QA Metrics.

- Review of report reissue requests.
- Review of client feedback and complaints.
- Issues arising from any prior management or staff meetings.
- Minutes from prior senior lab management meetings. Issues that may be raised from these meetings include:
  - Adequacy of staff, equipment and facility resources.
  - Adequacy of policies and procedures.
  - Future plans for resources and testing capability and capacity.
- The annual internal double blind PT program sample performance (if performed),
- Compliance to the Ethics Policy and Data Integrity Plan. Including any evidence/incidents of inappropriate actions or vulnerabilities related to data Integrity.

A report is generated by the QA Manager and management. The report is distributed to the appropriate General Manager and the Quality Director. The report includes, but is not limited to:

- The date of the review and the names and titles of participants.
- A reference to the existing data quality related documents and topics that were reviewed.
- 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)].

Changes to the quality systems requiring update to the laboratory QA Manual shall be included in the next revision of the QA Manual.

16.3 Potential Integrity Related Managerial Reviews

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 shall be followed (SOP No. CW-L-S-002). All investigations that result in finding of inappropriate activity are documented and include any disciplinary actions involved, corrective actions taken, and all appropriate notifications of clients.

TestAmerica’s COO, VP of Client & Technical Services, General Managers and Quality Directors receive a monthly report from the Director of Quality & Client Advocacy summarizing any current data integrity or data recall investigations. The General Manager’s are also made aware of progress on these issues for their specific labs.

SECTION 17. PERSONNEL

17.1 Overview

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.

All personnel must demonstrate competence in the areas where they have responsibility. Any staff that is undergoing training shall have appropriate supervision until they have demonstrated their ability to perform their job function on their own. Staff shall be qualified for their tasks based on appropriate education, training, experience and/or demonstrated skills as required.

The laboratory employs sufficient personnel with the necessary education, training, technical knowledge and experience for their assigned responsibilities.

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.

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 shall be relevant to the present and anticipated responsibilities of the lab staff.

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 to the laboratory's quality system.

17.2 Education and Experience Requirements for Technical Personnel

The laboratory makes every effort to hire analytical staffs that possess 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. 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.

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 site's Human Resources web-page.

As a general rule for analytical staff:

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)
GFAA, 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 1 year of college chemistry	Or 2 years prior analytical experience is required

Specialty	Education	Experience
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
Technology Manager / Department Manager– **General**	Bachelors Degree in an applied science or engineering. The Technology Manager must also have 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

When an analyst does not meet these requirements, they can perform a task under the direct supervision of a qualified peer or supervisors 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.

17.3 Training

The laboratory is committed to furthering the professional and technical development of employees at all levels.

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
Environmental Health & Safety	Prior to lab work	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

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.

The training of technical staff is kept up to date by:

- 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 in their area of responsibility. This documentation is updated as SOPs are updated.
- Documentation from any training courses or workshops on specific equipment, analytical techniques or other relevant topics are maintained in their training file.
- Documentation of proficiency (refer to Section 19).
- An Ethics Agreement signed by each staff member (renewed each year) and evidence of annual ethics training.
- A Confidentiality Agreement signed by each staff member signed at the time of employment.
- 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.

Evidence of successful training could include such items as:

- Adequate documentation of training within operational areas, including one-on-one technical training for individual technologies, and particularly for people cross-trained.
- Analysts knowledge to refer to QA Manual for quality issues.
- Analysts following SOPs, i.e., practice matches SOPs.
- Analysts regularly communicate to supervisors and QA if SOPs need revision, rather than waiting for auditors to find problems.

Further details of the laboratory's training program are described in the Laboratory Training SOP BR-QA-011.

17.4 Data Integrity and Ethics Training Program

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 1 week of hire followed by technical data integrity training within 30 days, comprehensive training within 90 days, and an annual refresher for all employees. Senior management at each facility performs the ethics training for their staff.

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 (Policy No. CW-L-P-004) and an Ethics Statement. All initial and annual training is documented by signature on the signed Ethics Statement demonstrating that the employee has participated in the training and understands their obligations related to ethical behavior and data integrity.

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, and for that reason, TestAmerica has a Zero Tolerance approach to such violations.
Employees are trained as to the legal and environmental repercussions that result from data misrepresentation. Key topics covered in the presentation include:

- Organizational mission and its relationship to the critical need for honesty and full disclosure in all analytical reporting.
- Ethics Policy
- How and when to report ethical/data integrity issues. Confidential reporting.
- Recordkeeping
- Discussion regarding data integrity procedures.
- Specific examples of breaches of ethical behavior (e.g. peak shaving, altering data or computer clocks, improper macros, etc., accepting/offering kickbacks, illegal accounting practices, unfair competition/collusion)
- Internal monitoring. Investigations and data recalls.
- Consequences for infractions including potential for immediate termination, debarment, or criminal prosecution.
- 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.

Additionally, a data integrity hotline (1-800-736-9407) is maintained by TestAmerica and administered by the Corporate Quality Department.

SECTION 18. ACCOMMODATIONS AND ENVIRONMENTAL CONDITIONS

18.1 Overview

The laboratory is a 22,000 ft^2 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.

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.

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.

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.

18.2 Environment

Laboratory accommodation, test areas, energy sources, 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.

The environment in which these activities are undertaken does not invalidate the results or adversely affect the required accuracy of any measurements.

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.

When any of the method or regulatory required environmental conditions change to a point where they may adversely affect test results, analytical testing will be discontinued until the environmental conditions are returned to the required levels.

Environmental conditions of the facility housing the computer network and LIMS are regulated to protect against raw data loss.

18.3 Work Areas

There is effective separation between neighboring areas when the activities therein are incompatible with each other. Examples include:

- Volatile organic chemical handling areas, including sample preparation and waste disposal, and volatile organic chemical analysis areas.

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.

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. Work areas are available to ensure an unencumbered work area. Work areas include:

- Access and entryways to the laboratory.
- Sample receipt areas.
- Sample storage areas.

- Chemical and waste storage areas.
- Data handling and storage areas.
- Sample processing areas.
- Sample analysis areas.

18.4 Floor Plan

A floor plan can be found in Appendix 1.

18.5 Building Security

Building cards are distributed to employees as necessary.

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 Environmental, Health and Safety Manual contains requirements for visitors and vendors. There are specific safety forms that must be reviewed and signed. 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. Signs are posted in the laboratory designating employee only areas - "Authorized employees beyond this point".

SECTION 19. TEST METHODS AND METHOD VALIDATION

19.1 Overview

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.

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.

19.2 Standard Operating Procedures (SOPS)

The laboratory maintains SOPs that accurately reflect all phases of the laboratory such as assessing data integrity, corrective actions, handling customer complaints as well as all analytical methods and sampling procedures. The method SOPs are derived from the most recently 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.

- All SOPs contain a revision number, effective date, and appropriate approval signatures. Controlled copies are available to all staff.
- Procedures for writing an SOP are incorporated by reference to TestAmerica's Corporate SOP entitled 'Writing a Standard Operating Procedure', No. CW-Q-S-002.
- SOPs are reviewed at a minimum of every 2 years except for SOPs for Drinking Water and DoD SOPs which are reviewed annually. Whenever necessary, SOPs may be revised to ensure continuing suitability and compliance with applicable requirements.

19.3 Laboratory Methods Manual

For each test method, the laboratory shall have available the published referenced method as well as the laboratory developed SOP.

Note: If more stringent standards or requirements are included in a mandated test method or regulation than those specified in this manual, the laboratory shall 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.

The laboratory maintains an SOP Index 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.

19.4 Selection of Methods

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), 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.

19.4.1 Sources of Methods

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 shall be used.

When clients do not specify the method to be used or methods are not required, the methods used will be clearly validated and documented in an SOP and available to clients and/or the end user of the data.

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:

- *Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air, US EPA, January 1996.*
- *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)*
- *Methods for Chemical Analysis of Water and Wastes, EPA 600 (4-79-020), 1983.*
- *Methods for the Determination of Inorganic Substances in Environmental Samples, EPA-600/R-93/100, August 1993.*
- *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.*
- *Methods for the Determination of Organic Compounds in Drinking Water, EPA-600/4-88-039, December 1988, Revised, July 1991, Supplement I, EPA-600-4-90-020, July 1990, Supplement II, EPA-600/R-92-129, August 1992. Supplement III EPA/600/R-95/131 - August 1995 (EPA 500 Series) (EPA 500 Series methods)*
- *Technical Notes on Drinking Water Methods, EPA-600/R94-173, October 1994*
- *NIOSH Manual of Analytical Methods, 4th ed., August 1994.*
- *Standard Methods for the Examination of Water and Wastewater, 18th/19th /20th/ 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.*
- *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.*
- *Annual Book of ASTM Standards, American Society for Testing & Materials (ASTM), Philadelphia, PA.*
- *National Status and Trends Program, National Oceanographic and Atmospheric Administration, Volume I-IV, 1985-1994.*
- *Manual for the Certification of Laboratories Analyzing Drinking Water (EPA 815-R-05-004, January 2005)*
- *Code of Federal Regulations (CFR) 40, Parts 136, 141, 172, 173, 178, 179 and 261*

The laboratory reviews updated versions to all the aforementioned references for adaptation based upon capabilities, 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.

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.

The laboratory shall 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 will be documented.

19.4.2 Demonstration of Capability

Before the laboratory may institute a new method and begin reporting results, the laboratory shall confirm that it can properly operate 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 sample. If the method is for the testing of analytes that are not conducive to spiking, demonstration of capability may be performed on quality control samples.

A demonstration of capability (DOC) is performed whenever there is a change in instrument type (e.g., new instrumentation), method or personnel (e.g., analyst hasn't performed the test within the last 12 months).

The initial demonstration of capability must be thoroughly documented and approved by the Technical Manager and QA Manager prior to independently analyzing client samples. All associated documentation must be retained in accordance with the laboratories archiving procedures.

The laboratory must have an approved SOP, demonstrate satisfactory performance, and conduct an MDL study (when applicable). There may be other requirements as stated within the published method or regulations (i.e., retention time window study).

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 Demonstration of Capability). If the client states that the information is not for regulatory purposes, the result may be reported as long as the following criteria are met:

- The instrument is calibrated for the analyte to be reported using the criteria for the method and ICV/CCV criteria are met (unless an ICV/CCV is not required by the method or criteria are per project DQOs).
- 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 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).
- 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: *Reporting Limit based on the low standard of the calibration curve.*

19.4.3 Initial Demonstration of Capability (IDOC) Procedures

19.4.3.1 The spiking standard used should be prepared independently from those used in instrument calibration.

19.4.3.2 The analyte(s) shall be diluted in a volume of clean matrix sufficient to prepare four aliquots at the concentration specified by a method or the laboratory SOP.

19.4.3.3 At least four aliquots shall be prepared (including any applicable clean-up procedures) and analyzed according to the test method (either concurrently or over a period of days).

19.4.3.4 Using all of the results, calculate the mean recovery in the appropriate reporting units and the standard deviations for each parameter of interest.

19.4.3.5 When it is not possible to determine the mean and standard deviations, such as for presence, absence and logarithmic values, the laboratory will assess performance against criteria described in the Method SOP.

19.4.3.6 Compare the information obtained above to the corresponding acceptance criteria for precision and accuracy in the test method (if applicable) or in laboratory generated acceptance criteria (LCS or interim criteria) if there is no mandatory criteria established. If any one of the parameters do not meet the acceptance criteria, the performance is unacceptable for that parameter.

19.4.3.7 When one or more of the tested parameters fail at least one of the acceptance criteria, the analyst must proceed according to either option listed below:

- Locate and correct the source of the problem and repeat the test for all parameters of interest beginning with 19.4.3.3 above.
- Beginning with 19.4.3.3 above, repeat the test for all parameters that failed to meet criteria. Repeated failure, however, will confirm a general problem with the measurement system. If this occurs, locate and correct the source of the problem and repeat the test for all compounds of interest beginning with 19.4.3.1 above.

Note: Results of successive LCS analyses can be used to fulfill the DOC requirement.

A certification statement (refer to Figure 19-1 as an example) shall be used to document the completion of each initial demonstration of capability. A copy of the certification is archived in the analyst’s training folder.

19.5 Laboratory Developed Methods and Non-Standard Methods

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 also be in agreement to the use of the non-standard method.

19.6 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.

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 fit 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.

19.6.1 Method Validation and Verification Activities for All New Methods

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.

19.6.1.1 Determination of Method Selectivity

Method selectivity is the demonstrated ability to discriminate the analyte(s) of interest from other compounds in the specific matrix or matrices from other analytes or interference. In some cases to achieve the required selectivity for an analyte, a confirmation analysis is required as part of the method.

19.6.1.2 Determination of Method Sensitivity

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.

19.6.1.3 Relationship of Limit of Detection (LOD) to the Quantitation Limit (QL)

An important characteristic of expression of sensitivity is the difference in the LOD and the QL. The LOD is the minimum level at which the presence of an analyte can be reliably concluded. The QL is the minimum concentration of analyte that can be quantitatively determined with acceptable precision and bias. For most instrumental measurement systems, there is a region where semi-quantitative data is generated around the LOD (both above and below the estimated MDL or LOD) and below the QL. In this region, detection of an analyte may be confirmed but quantification of the analyte is unreliable within the accuracy and precision guidelines of the measurement system. When an analyte is detected below the QL, and the presence of the analyte is confirmed by meeting the qualitative identification criteria for the analyte, the analyte can be reliably reported, but the amount of the analyte can only be estimated. If data is to be reported in this region, it must be done so with a qualification that denotes the semi-quantitative nature of the result.

19.6.1.4 Determination of Interferences

A determination that the method is free from interferences in a blank matrix is performed.

19.6.1.5 Determination of Range

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 QL cannot be lower than the lowest non-zero calibration level, and can be constrained by required levels of bias and precision.

19.6.1.6 Determination of Accuracy and Precision

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.

19.6.1.7 Documentation of Method

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 describing the specific differences in the new method is acceptable in place of a separate SOP.

19.6.1.8 Continued Demonstration of Method Performance

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.

19.7 Method Detection Limits (MDL) / Limits of Detection (LOD)

Method detection limits (MDL) are initially determined in accordance with 40 CFR Part 136, Appendix B or alternatively by other technically acceptable 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. 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.

Refer to the laboratory SOP No. BR-QA-005 for details on the laboratory's MDL process, including detection limit procedures specific to the CLP SOWs for ISM and SOM.

19.8 Instrument Detection Limits (IDL)

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 demonstration of instrument performance in other areas.

IDLs are calculated to determine an instrument's sensitivity independent of any preparation method. IDLs are calculated either using 7 replicate spike analyses, like MDL but without sample preparation, or by the analysis of 10 instrument blanks and calculating 3 x the absolute value of the standard deviation.

If IDL is > than the MDL, it may be used as the reported MDL.

19.9 Verification of Detection and Reporting Limits

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 BR-QA-005 Method Detection Limits (MDLs/DLs) for further details.

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 bias and precision at the LOQ and quarterly LOQ verifications thereafter. If the quarterly verification results are not consistent with three-standard deviation confidence limits established initially, then the bias 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 may be higher.

19.10 Retention Time Windows

Most organic analyses and some inorganic analyses use chromatography techniques for qualitative and quantitative determinations. For every chromatography analysis or as specific in the reference method, 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. Complete details are available in the laboratory SOPs.

19.11 Evaluation of Selectivity

The laboratory evaluates selectivity by following the checks within the applicable analytical methods, which include mass spectral tuning, second column confirmation, ICP interelement interference checks, chromatography retention time windows, sample blanks, spectrochemical, atomic absorption or fluorescence profiles, co-precipitation evaluations and specific electrode response factors.

19.12 Estimation of Uncertainty of Measurement

19.12.1 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 measurand" (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 measurand is believed to lie within at least a 95% confidence level with the coverage factor k=2.

19.12.2 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.

19.12.3 The minimum uncertainty associated with results generated by the laboratory 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.

19.12.4 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 a 99%-certain range for the reported result. As an example, suppose that the result reported is 1.0 mg/l, and the LCS percent recovery range is 50 to 150%. The uncertainty range would be 0.5 to 1.5 mg/l, which could also be written as 1.0 +/- 0.5 mg/l.

19.12.5 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.

19.13 Sample Reanalysis Guidelines

Because there is a certain level of uncertainty with any analytical measurement, a sample re-preparation (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 homogeneity, analyte precipitation 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 or Contractual Terms & Conditions for reanalysis protocols may supersede the following items.

- Homogenous samples: If a reanalysis 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.

- If the reanalysis does not agree (as defined above) with the original result, then the laboratory will investigate the discrepancy and may reanalyze the sample a third time for confirmation if sufficient sample is available.

- 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.

19.14 Control of Data

The laboratory has policies and procedures in place to ensure the authenticity, integrity, and accuracy of the analytical data generated by the laboratory.

19.14.1 Computer and Electronic Data Related Requirements

The three basic objectives of our computer security procedures and policies are shown below. More detail is outlined in corporate IT procedure and policies. The laboratory is currently running TALS which is a custom in-house developed LIMS system 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 an SQL database which is an industry standard relational database platform. It is referred to as Database for the remainder of this section.

19.14.1.1 Maintain the Database Integrity: Assurance 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.

- LIMS Database Integrity is achieved through data input validation, internal user controls, and data change requirements.
- 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.
- Instrument hardware and software adjustments are safeguarded through maintenance logs, audit trails and controlled access.

19.14.1.2 **Ensure Information Availability:** 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.

19.14.1.3 **Maintain Confidentiality:** Ensure data confidentiality through physical access controls such as password protextion or website access approval when electronically transmitting data.

19.14.2 Data Reduction

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.

Manual integration of peaks will be documented and reviewed and the raw data will be flagged in accordance with the TestAmerica Corporate SOP No. CA-Q-S-002, *Acceptable Manual Integration Practices* and laboratory SOP BR-QA-006.

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 indication; otherwise, it should 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.

19.14.2.1 All raw data must be retained in the worklist folder, computer file (if appropriate), and/or runlog. 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). It must be easily identifiable who performed which tasks if multiple people were involved.

19.14.2.2 In general, concentration 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. For values greater than 10,000 mg/l, results can be reported in percent, i.e., 10,000 mg/l = 1**%.** Units are defined in each lab SOP.

19.14.2.3 In reporting, the analyst or the instrument output records the raw data result using values of known certainty plus one uncertain digit. If final calculations are performed external to LIMS, the results should be entered in LIMS with at least three significant figures. In general, results are reported to the number of significant figured programmed in the LIMS formatter selected by the PM.

19.14.2.4 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.

19.14.2.5 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 poor spectrally-matched compounds. The analyst prints a copy of what has been entered to check for errors. This printout and the instrument's printout of calibrations, concentrations, retention times, chromatograms, and mass spectra, if applicable, are retained with the data file. The data file is stored in a monthly folder on the instrument computer; periodically, this file is transferred to the server and, eventually, to a tape file.

19.14.3 Logbook / Worksheet Use Guidelines

Logbooks and worksheets are filled out '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, calculations are traceable, etc.)

- Corrections are made following the procedures outlined in Section 12.
- Logbooks are controlled by the QA department. A record is maintained of all logbooks in the lab.
- Unused portions of pages must be "Z"'d out, signed and dated.
- Worksheets are created with the approval of the QA Manager at the facility. The QA department controls all worksheets following the procedures in Section 6.

19.14.4 Review / Verification Procedures

Review procedures are out lined in several SOP BR-QA-019 to ensure that reported data are free from calculation and transcription errors, that QC parameters have been reviewed and evaluated before data is reported. The laboratory also has an SOP for manual integration, BR-QA-005. The general review concepts are discussed below, more specific information can be found in the SOPs.

19.14.4.1 The data review process at the laboratory starts at the Sample Control level. Sample Control personnel review chain-of-custody forms and input the sample information and required analyses into a computer LIMS. The Sample Control Supervisor reviews the transaction of the chain-of-custody forms and the inputted information. The Project Managers perform final review of the chain-of-custody forms and inputted information.

19.14.4.2 The next level of data review occurs with the Analysts. As results are generated, analysts review their work to ensure that the results generated meet QC requirements and relevant EPA methodologies. The Analysts transfer the data into the LIMS and add data qualifiers if applicable. To ensure data compliance, a different analyst performs a second level of review. Second level review is accomplished by checking reported results against raw data and evaluating the results for accuracy. During the second level review, blank runs, QA/QC check results, initial and continuing calibration results, laboratory control samples, sample data, qualifiers and spike information are evaluated. Where calibration is not required on a daily basis, secondary review of the initial calibration results may be conducted at the time of calibration. Approximately 15% of all sample data from manual methods and from automated methods, all GC/MS spectra and all manual integrations are reviewed. Manual integrations are also electronically reviewed utilizing auditing software to help ensure compliance to ethics and manual integration policies. Issues that deem further review include the following:

- QC data are outside the specified control limits for accuracy and precision
- Reviewed sample data does not match with reported results
- Unusual detection limit changes are observed
- Samples having unusually high results
- Samples exceeding a known regulatory limit
- Raw data indicating some type of contamination or poor technique
- Inconsistent peak integration
- Transcription errors
- Results outside of calibration range

19.14.4.3 Unacceptable analytical results may require reanalysis of the samples. Any problems are brought to the attention of the Department Manager, Project Manager, QA Manager or Technology Manager, as necessary. Corrective action is initiated whenever necessary.

19.14.4.4 The results are then entered or directly transferred into the computer database and a report is prepared for the client.

19.14.4.5 As a final review prior to the release of the report, the Project Manager reviews the report for completeness. This review and approval ensures that client requirements have been met and that the final report has been properly completed. The process includes, but is not limited to, verifying that chemical relationships are evaluated, COC is followed, cover letters/ narratives are present, flags are appropriate, and project specific requirements are met.

19.14.4.6 Any project that requires a data package is subject to a tertiary data review for transcription errors and acceptable quality control requirements. The Project Manager then signs the final report. The accounting personnel also check the report for any clerical or invoicing errors. When complete, the report is sent out to the client.

19.14.5 Manual Integrations

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 acceptance 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) as the guideline for our internal SOP BR-QA-006.

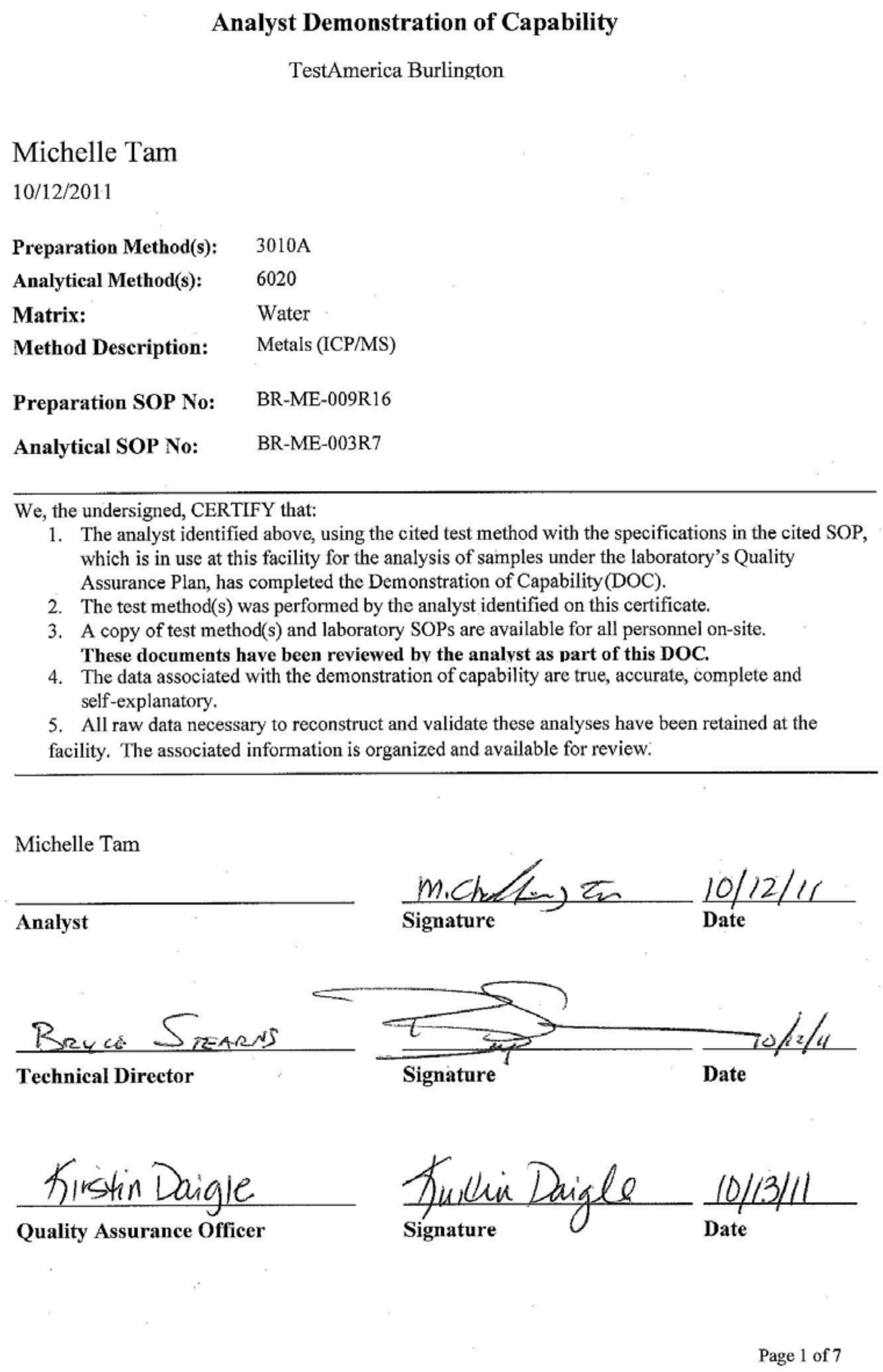
19.14.5.1 The analyst must adjust baseline or the area of a peak in some situations, for example when two compounds are not adequately resolved or when a peak shoulder needs to be separated from the peak of interest. The analyst must use professional judgment and common sense to determine when manual integrating is required. Analysts are encouraged to ask for assistance from a senior analyst or manager when in doubt.

19.14.5.2 Analysts shall 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.

19.14.5.3 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.

19.14.5.4 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



Analyst Demonstration of Capability

TestAmerica Burlington

Michelle Tam
10/12/2011

Preparation Method(s):	3010A
Analytical Method(s):	6020
Matrix:	Water
Method Description:	Metals (ICP/MS)
Preparation SOP No:	BR-ME-009R16
Analytical SOP No:	BR-ME-003R7

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 this 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. A copy of test method(s) and laboratory SOPs are available for all personnel on-site. **These documents have been reviewed by the analyst as part of this DOC.**
4. The data associated with the demonstration of capability are true, accurate, complete and self-explanatory.
5. All raw data necessary to reconstruct and validate these analyses have been retained at the facility. The associated information is organized and available for review.

Michelle Tam
Analyst **Signature** 10/12/11 **Date**

Bryce Stearns
Technical Director **Signature** 10/12/11 **Date**

Kristin Daigle
Quality Assurance Officer Kristin Daigle **Signature** 10/13/11 **Date**

SECTION 20. EQUIPMENT and CALIBRATIONS

20.1 Overview

The laboratory purchases the most 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 establish that it meets its intended specification. The calibration routines for analytical instruments establish the range of quantitation. Calibration procedures are specified in laboratory SOPs. A list of laboratory instrumentation is presented in Table 20-1.

Equipment is only operated by authorized and trained personnel. Manufacturers instructions for equipment use are readily accessible to all appropriate laboratory personnel.

20.2 Preventive Maintenance

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.

Routine preventive maintenance procedures and frequency, such as cleaning and replacements, should be performed according to the procedures outlined in the manufacturer's manual. Qualified personnel must 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.

Table 20-2 lists examples of scheduled routine maintenance. It is the responsibility of each Department Manager to ensure that instrument maintenance logs are kept for all equipment in his/her department. Preventative maintenance procedures may be / are also outlined in analytical SOPs or instrument manuals.

Instrument maintenance logs are controlled and are used to document instrument problems, instrument repair and maintenance activities. Maintenance logs shall be kept for all major pieces of equipment. Instrument maintenance logs may also be used to specify instrument parameters.

- Documentation must include all major maintenance activities such as contracted preventive maintenance and service and in-house activities such as the replacement of electrical components, lamps, tubing, valves, columns, detectors, cleaning and adjustments.
- Each entry in the instrument log includes the Analyst's initials, the 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.

- 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 that it is clear that a page is missing if only half a signature is found in the logbook.

If an instrument requires repair (subjected to overloading or mishandling, gives suspect results, or otherwise has shown to be defective or outside of specified limits) it shall 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 shall examine the effect of this defect on previous analyses.

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. Back up instruments, which have been approved, for the analysis shall perform the analysis normally carried out by the malfunctioning instrument. If the back up is not available and the analysis cannot be carried out within the needed timeframe, the samples shall be subcontracted.

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.

20.3 Support Equipment

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, thermal/pressure sample preparation devices and volumetric 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 instrument performance.

20.3.1 Weights and Balances

The accuracy of the balances used in the laboratory is checked every working day, before use. All balances are placed on stable counter tops.

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 5 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).

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.

All of this information is recorded in logs, and the recalibration/recertification certificates are kept on file.

20.3.2 pH, Conductivity, and Turbidity Meters

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.

Conductivity meters are also calibrated before each use with a known standard to demonstrate the meters do not exceed an error of 1% or one umhos/cm.

Turbidity meters are also calibrated before each use. All of this information is documented in logs.

Consult pH and Conductivity, and Turbidity SOPs for further information.

20.3.3 Thermometers

All thermometers are calibrated on an annual basis with a NIST-traceable thermometer. IR thermometers, digital probes and thermocouples are calibrated quarterly.

The mercury/digital NIST thermometer is recalibrated every 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.

All of this information is documented in logbooks. Monitoring method-specific temperatures, including incubators, heating blocks, water baths, and ovens, is documented in support equipment logbooks.

20.3.4 Refrigerators/Freezer Units, Waterbaths, Ovens and Incubators

The temperatures of all refrigerator units and freezers used for sample and standard storage are monitored each day.

Ovens, waterbaths and incubators are monitored on days of use.

All of this equipment has a unique identification number, and is assigned a unique thermometer for monitoring.

Sample storage refrigerator temperatures are kept between > 0ºC and ≤ 6 ºC.

Specific temperature settings/ranges for other refrigerators, ovens waterbaths, and incubators can be found in method specific SOPs.

All of this information is documented in logbooks designated for this purpose.

20.3.5 Autopipettors, Dilutors, and Syringes

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.

For those dispensers that are not used for analytical measurements, a label is applied to the device stating that it is not calibrated. Any device not regularly verified can not be used for any quantitative measurements.

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.

20.4 Instrument Calibrations

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.

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.)

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.

If the initial calibration results are outside of the acceptance criteria, corrective action is performed and any affected samples are reanalyzed if possible. If the reanalysis is not possible, any data associated with an unacceptable initial calibration will be reported with appropriate data qualifiers (refer to Section 12).

Note: Instruments are calibrated initially and as needed after that and at least annually. Except isotopic dilution methods do not require annual calibration.

20.4.1 Calibration Standards

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 3 calibration points (exception being ICP and ICP/MS methods) will be used.

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.

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).

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 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.

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 at a different time or a different preparation would be considered a second source. This verification occurs immediately after the calibration curve has been analyzed, and before the analysis of any samples.

20.4.1.1 Calibration Verification

The calibration relationship established during the initial calibration must be verified initially and at least daily as specified in the laboratory method SOPs in accordance with the referenced analytical methods 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. Initial calibration verification is with a standard source secondary (second source standard) to the calibration standards, but continuing calibration verifications may use the same source standards as the calibration curve.

Note: The process of calibration verification referred to here 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.

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 Std. EL-V1M4 Sec. 1.7.2.

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 (basically GCMS) 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).

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, QC, or standard that can be injected within 12 hours of the beginning of the shift.

A continuing instrument calibration verification (CCV) 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 (basically GCMS) 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).

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 & documented, the laboratory shall demonstrate acceptable instrument / method performance by analyzing two consecutive CCVs, or a new initial instrument calibration shall be performed.

Sample analyses and reporting of data may not occur or continue until the analytical system is calibrated or calibration verified. However, data associated with an unacceptable calibration verification may be fully useable based upon discussion and approval of the client:

a). when the 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

b). 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.

Samples reported by the 2 conditions identified above will be appropriately flagged.

20.4.1.2 Verification of Linear and Non-Linear Calibrations

Calibration verification for 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.

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.

- 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.

- 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. Alternatively, a reporting limit standard may be analyzed to demonstrate that the laboratory can still support non-detects at their reporting limit.

20.5 Tentatively Identified Compounds (TICs) – GC/MS Analysis

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.

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).

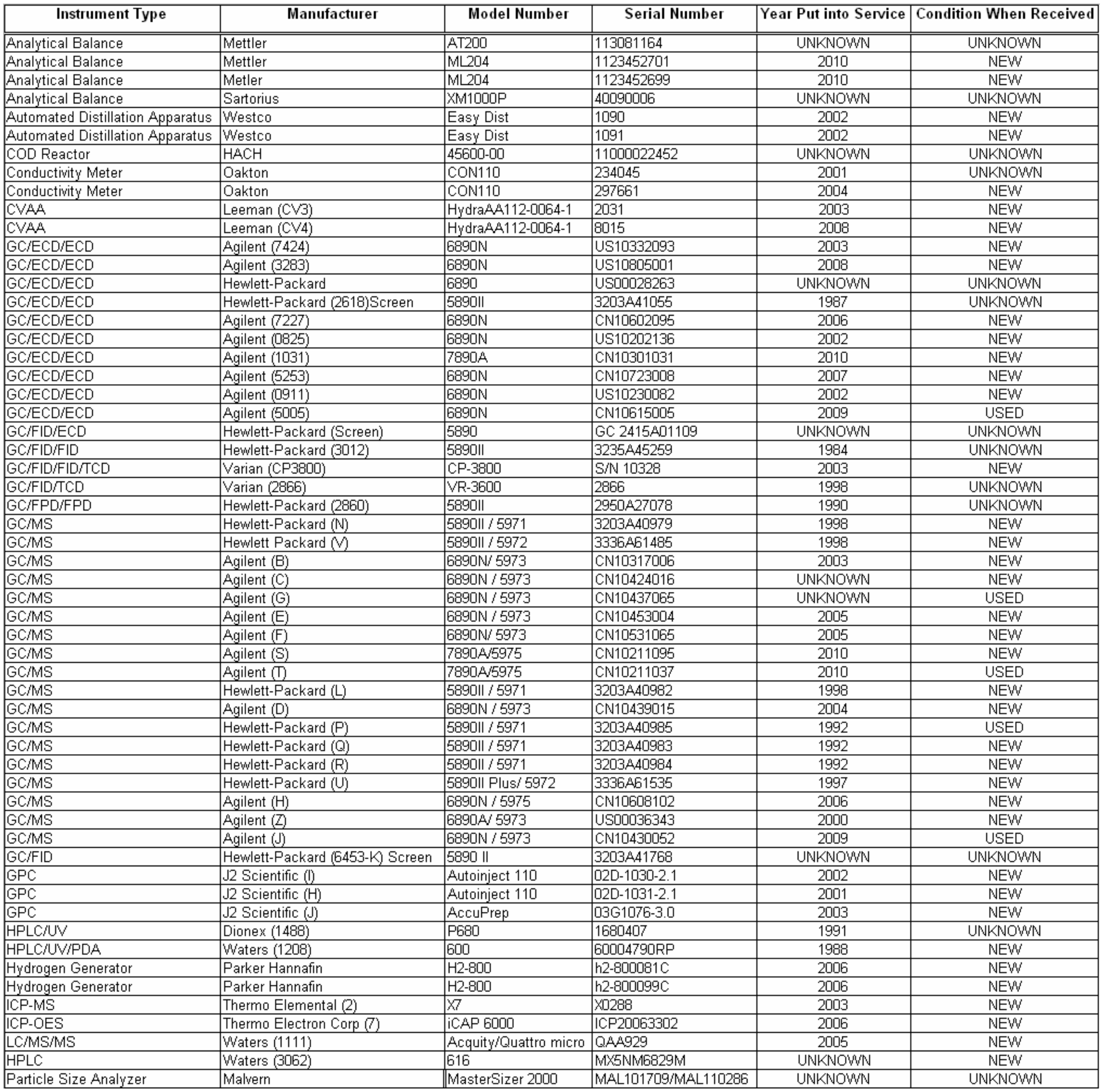
For example, the RCRA permit or waste delisting requirements may require the reporting of non-target analytes. Only after visual comparison of sample spectra with the nearest library searches may the analyst assign a tentative identification.

20.6 GC/MS Tuning

Prior to any GCMS analytical sequence, including calibration, the instrument parameters for the tune and subsequent sample analyses within that sequence must be set.

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. Example: Instrumentation List



Instrument Type	Manufacturer	Model Number	Serial Number	Year Put into Service	Condition When Received
Analytical Balance	Mettler	AT200	113081164	UNKNOWN	UNKNOWN
Analytical Balance	Mettler	ML204	1123452701	2010	NEW
Analytical Balance	Metler	ML204	1123452699	2010	NEW
Analytical Balance	Sartorius	XM1000P	40090006	UNKNOWN	UNKNOWN
Automated Distillation Apparatus	Westco	Easy Dist	1090	2002	NEW
Automated Distillation Apparatus	Westco	Easy Dist	1091	2002	NEW
COD Reactor	HACH	45600-00	11000022452	UNKNOWN	UNKNOWN
Conductivity Meter	Oakton	CON110	234045	2001	UNKNOWN
Conductivity Meter	Oakton	CON110	297661	2004	NEW
CVAA	Leeman (CV3)	HydraAA112-0064-1	2031	2003	NEW
CVAA	Leeman (CV4)	HydraAA112-0064-1	8015	2008	NEW
GC/ECD/ECD	Agilent (7424)	6890N	US10332093	2003	NEW
GC/ECD/ECD	Agilent (3283)	6890N	US10805001	2008	NEW
GC/ECD/ECD	Hewlett-Packard	6890	US00028263	UNKNOWN	UNKNOWN
GC/ECD/ECD	Hewlett-Packard (2618)Screen	5890II	3203A41055	1987	UNKNOWN
GC/ECD/ECD	Agilent (7227)	6890N	CN10602095	2006	NEW
GC/ECD/ECD	Agilent (0825)	6890N	US10202136	2002	NEW
GC/ECD/ECD	Agilent (1031)	7890A	CN10301031	2010	NEW
GC/ECD/ECD	Agilent (5253)	6890N	CN10723008	2007	NEW
GC/ECD/ECD	Agilent (0911)	6890N	US10230082	2002	NEW
GC/ECD/ECD	Agilent (5005)	6890N	CN10615005	2009	USED
GC/FID/ECD	Hewlett-Packard (Screen)	5890	GC 2415A01109	UNKNOWN	UNKNOWN
GC/FID/FID	Hewlett-Packard (3012)	5890II	3235A45259	1984	UNKNOWN
GC/FID/FID/TCD	Varian (CP3800)	CP-3800	S/N 10328	2003	NEW
GC/FID/TCD	Varian (2866)	VR-3600	2866	1998	UNKNOWN
GC/FPD/FPD	Hewlett-Packard (2860)	5890II	2950A27078	1990	UNKNOWN
GC/MS	Hewlett-Packard (N)	5890II / 5971	3203A40979	1998	NEW
GC/MS	Hewlett Packard (V)	5890II / 5972	3336A61485	1998	NEW
GC/MS	Agilent (B)	6890N/ 5973	CN10317006	2003	NEW
GC/MS	Agilent (C)	6890N / 5973	CN10424016	UNKNOWN	NEW
GC/MS	Agilent (G)	6890N / 5973	CN10437065	UNKNOWN	USED
GC/MS	Agilent (E)	6890N / 5973	CN10453004	2005	NEW
GC/MS	Agilent (F)	6890N/ 5973	CN10531065	2005	NEW
GC/MS	Agilent (S)	7890A/5975	CN10211095	2010	NEW
GC/MS	Agilent (T)	7890A/5975	CN10211037	2010	USED
GC/MS	Hewlett-Packard (L)	5890II / 5971	3203A40982	1998	NEW
GC/MS	Agilent (D)	6890N / 5973	CN10439015	2004	NEW
GC/MS	Hewlett-Packard (P)	5890II / 5971	3203A40985	1992	USED
GC/MS	Hewlett-Packard (Q)	5890II / 5971	3203A40983	1992	NEW
GC/MS	Hewlett-Packard (R)	5890II / 5971	3203A40984	1992	NEW
GC/MS	Hewlett-Packard (U)	5890II Plus/ 5972	3336A61535	1997	NEW
GC/MS	Agilent (H)	6890N / 5975	CN10608102	2006	NEW
GC/MS	Agilent (Z)	6890A/ 5973	US00036343	2000	NEW
GC/MS	Agilent (J)	6890N / 5973	CN10430052	2009	USED
GC/FID	Hewlett-Packard (6453-K) Screen	5890 II	3203A41768	UNKNOWN	UNKNOWN
GPC	J2 Scientific (I)	Autoinject 110	02D-1030-2.1	2002	NEW
GPC	J2 Scientific (H)	Autoinject 110	02D-1031-2.1	2001	NEW
GPC	J2 Scientific (J)	AccuPrep	03G1076-3.0	2003	NEW
HPLC/UV	Dionex (1488)	P680	1680407	1991	UNKNOWN
HPLC/UV/PDA	Waters (1208)	600	60004790RP	1988	NEW
Hydrogen Generator	Parker Hannafin	H2-800	h2-800081C	2006	NEW
Hydrogen Generator	Parker Hannafin	H2-800	h2-800099C	2006	NEW
ICP-MS	Thermo Elemental (2)	X7	X0288	2003	NEW
ICP-OES	Thermo Electron Corp (7)	iCAP 6000	ICP20063302	2006	NEW
LC/MS/MS	Waters (1111)	Acquity/Quattro micro	QAA929	2005	NEW
HPLC	Waters (3062)	616	MX5NM6829M	UNKNOWN	NEW
Particle Size Analyzer	Malvern	MasterSizer 2000	MAL101709/MAL110286	UNKNOWN	UNKNOWN

Instrument Type	Manufacturer	Model Number	Serial Number	Year Put into Service	Condition When Received
pH Meter	Denver Instruments	UB-5	UB503B365	UNKNOWN	UNKNOWN
Soxtherm	Gerhardt (SOXA)	SE3AS306A	4012396	UNKNOWN	UNKNOWN
Soxtherm	Gerhardt (SOXB)	SE3AS306A	4022047	UNKNOWN	UNKNOWN
Soxtherm	Gerhardt (SOXC)	SE3AS306A	4022046	UNKNOWN	UNKNOWN
Soxtherm	Gerhardt (SOXD)	SE3AS306A	4022045	UNKNOWN	UNKNOWN
Soxtherm	Gerhardt (SOXE)	SE3AS306A	4022030	UNKNOWN	UNKNOWN
Soxtherm	Gerhardt (SOXF)	SE3AS306A	4012397	UNKNOWN	UNKNOWN
Soxtherm	Gerhardt (SOXG)	SE-416	4051586	2012	USED
Soxtherm	Gerhardt (SOXH)	SE-416	4031739	2012	USED
Soxtherm	Gerhardt (SOXI)	SE-416	4031738	2012	USED
Soxtherm	Gerhardt (SOXJ)	SE-416	4031737	2012	USED
TKN Digestion System	Aim Lab	AIM600 Block	5048A23014	2011	NEW
Elemental Analyzer (TOC)	Carlo Erba	NA 1500	220465	1991	UNKNOWN
Elemental Analyzer (TOC)	Carlo Erba	EA1108	249146	1991	NEW
Nitrogen/Protein Analyzer	Costech	4010	231009973	2005	UNKNOWN
TOC Analyzer	Shimadzu	TOC-V CPH	H51314800321AE	2011	NEW
Turbidimeter	HF Scientific	Micro 100	208463	2001	UNKNOWN
Spectrophotometer	Genesys	Spectronic 20	3SGB029021	1999	UNKNOWN
Spectrophotometer	Genesys	Spectronic 20	3SGE165024	2002	UNKNOWN
Flow Injection Analyzer	Lachat	QuikChem 8000	A83000-2167	2000	UNKNOWN

Table 20-2. Example: Schedule of Routine Maintenance

Instrument	Procedure	Frequency
Leeman Mercury Analyzer	Check Peristaltic Pump tubing	As required
	Lubricate Autosampler rods	Monthly
	Clean Autosampler	Weekly
	Check and fill Rinse Vessel	As required
	Check and fill Stannous Chloride	As required
	Check Waste Vessel	Daily
	Empty Waste Vessel	As required
ICP	Check Peristaltic Pump tubing	As required
	Clean Torch	Daily
	Replace Torch	As required
	Check and fill Rinse Vessel	As required
	Check and fill IS Vessel	As required
	Fill Standards Cup	Daily
	Check Waste Vessel	Daily
	Empty Waste Vessel	As required
	Check and clean Cones	As required
	Perform Auto Peak Adjustment	As required
ICP MS	Check Peristaltic Pump tubing	As required
	Clean Torch	As required
	Check and fill Rinse Vessel	As required
	Check and fill IS Vessel	As required
	Fill standards cup	Daily
	Check Waste Vessel	Daily
	Empty Waste Vessel	As required
	Check and clean Cones	As required
UV-Vis Spectrophotometer	Clean ambient flow cell	As required
	Wavelength verification check	As required
	Clean Cuvette with Cuvette Cleaning Solution	As required
Hewlett Packard GC/MS (VOA)	Clean Injection Port and Liner	As required
	Change Septa	As required
	Cut 2-3 inches from GC Column	As required
	Fill Autosampler rinse vials	As required
	Clean Purge and Trap mount and purge vessel	As required
	Check Purge Flow	As required

Instrument	Procedure	Frequency
Hewlett Packard GC/MS (SVOA)	Clean Injection Port and Liner Change Septa Replace or clip Guard Column Replace or clip Analytical Column Fill Autosampler rinse vials	Daily Daily Daily Daily Daily
Hewlett Packard GC/MS (Air)	Check GC / Entech Column Interface Check Nitrogen Tank Volume Check Nitrogen Valves Software and Valves Cut 2-3 inches from GC Column	As required As required As required As required
Gas Chromatograph	Replace Septa Clean and replace Injection Port Liner Replace or clip Guard Column Replace or clip Analytical Column Bake, Re-foil, Refurbish Detector	As required As required As required As required As required
Zero Air Generator	Change pre-filter cartridge Replace catalyst module Check Indicator Beads in Moisture Filters Bake and Refill Mol Sieve Dry Rite Beads	Annually Indicator Light Blinks Daily As required
Hydrogen Generator	Fill Water Reservoir Replace Water in Water Reservoir Replace Ionic Bags in Water Reservoir	Daily Semi-Annually Semi-Annually
HPLC	Change Transfer Lines Replace Guard Column Replace Analytical Column Replace or clean Pump Head Check Valves Change Plunger Seals Change Suppressor Change Eluent Generator Cartridge and CR-ATC	As required As required As required As required As required As required As required
LC/MS/MS	Replace Guard Column Replace Analytical Column Replace or clean Pump Head Check Valves Change Plunger Seals Change In Line Filter Clean or Change Sample Cone Clean Source	As required As required As required As required As required As required As required
Balances	Class “1” traceable weight check Clean pan and check if level Field service	Daily, when used Daily Annually
Latchat	Change Tubing Replace Bulb	As required As required
Conductivity Meter	Calibrate	Daily
Turbidimeter	Calibrate Check light bulb	As required Daily, when used
Drying Ovens	Temperature monitoring Temperature adjustments	Daily As required
Refrigerators/ Freezers	Temperature monitoring Temperature adjustment Defrosting/cleaning	Daily As required As required
pH/Specific Ion Meter	Calibrate Clean electrode	Daily As required
Centrifuge	Check brushes and bearings	Every 6 months or as needed

Instrument	Procedure	Frequency
Water baths	Temperature monitoring Water replaced	Daily, when used Monthly or as needed

SECTION 21. MEASUREMENT TRACEABILITY

21.1 Overview

Traceability of measurements shall 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 shall 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. 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 is suspect, the accuracy of the glassware will be assessed prior to use.

21.2 NIST-Traceable Weights and Thermometers

Reference standards of measurement shall 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.

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 EA (European Cooperation for Accreditation). A certificate and scope of accreditation is kept on file at the laboratory.

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

Reference standards/materials, where commercially available, are traceable to certified reference materials. Commercially prepared standard materials are purchased from vendors with an accompanying Certificate of Analysis that documents the standard purity. If a standard cannot be purchased from a vendor that supplies a Certificate of Analysis, the purity of the standard is documented by analysis. 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.

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, 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. 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).

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 or laboratory SOPs. For safety requirements, please refer to method SOPs and the laboratory Environmental Health and Safety Manual.

Standards and reference materials shall 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.

21.4 Documentation and Labeling of Standards, Reagents, and Reference Materials

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 company wide purchase. [Refer to TestAmerica's Corporate SOP (CA-Q-S-001), Solvent and Acid Lot Testing and Approval.]

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 lab section**.** 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. For detailed information on documentation and labeling, please refer to method specific SOPs.

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 will be made to concentrations applied to solutions prepared from the stock commercial material.

21.4.1 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.

- Standard ID
- Description of Standard
- Preparer's name
- Final volume
- Solvent type and lot number
- Preparation Date
- Expiration Date
- Parent standard ID (if applicable)
- Parent Standard Analyte Concentration (if applicable)
- Parent Standard Amount used (if applicable)
- Component Analytes
- Final concentration of each analyte
- Comment box (text field)

Records are maintained electronically 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.

21.4.2 All standards, reagents, and reference materials must be clearly labeled with a minimum of the following information:

- Expiration Date (include prep date for reagents)
- Standard ID
- Special Health/Safety warnings if applicable

Records must also be maintained of the date of receipt for commercially purchased items or date of preparation for laboratory prepared items. Special Health/Safety warnings must also be available to the analyst. This information is maintained on the company's intranet and in test method SOPs.

21.4.3 In addition, the following information may be helpful:

- Date opened (for multi-use containers, if applicable)
- Description of standard (if different from manufacturer's label or if standard was prepared in the laboratory)
- Concentration (if applicable)
- Initials of analyst preparing standard or opening container

All containers of prepared reagents must include expiration date and an ID number to trace back to preparation.

Procedures for preparation of reagents can be found in the Method SOPs.

Standard ID numbers must be traceable through associated logbooks, worksheets and raw data.

All reagents and standards must be stored in accordance to the following priority: 1) with the manufacturer's recommendations; 2) with requirements in the specific analytical methods as specified in the laboratory SOP.

SECTION 22. SAMPLING

22.1 Overview

The laboratory does not provide sampling services. The laboratory's responsibility in the sample collection process lies in supplying the sampler with the necessary coolers, reagent water, sample containers, preservatives, sample labels, custody seals, COC forms, ice, and packing materials required to properly preserve, pack, and ship samples to the laboratory

22.2 Sampling Containers

The laboratory offers clean sampling containers for use by clients. These containers are obtained from reputable container manufacturers and meet EPA specifications as required. Any certificates of cleanliness that are provided by the supplier are maintained at the laboratory.

22.2.1 Preservatives

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:

- Hydrochloric Acid – Reagent ACS (Certified VOA Free) or equivalent
- Methanol – Purge and Trap grade
- Nitric Acid – Instra-Analyzed or equivalent
- Sodium Bisulfate – ACS Grade or equivalent
- Sodium Hydroxide – Instra-Analyzed or equivalent
- Sulfuric Acid – Instra-Analyzed or equivalent
- Sodium Thiosulfate – ACS Grade or equivalent

22.3 Definition of Holding Time

The date and time of sampling documented on the 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 twenty-four hours after sampling. Holding times for analysis include any necessary reanalysis. 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 how long the holding time is.

22.4 Sampling Containers, Preservation Requirements, Holding Times

The preservation and holding time criteria specified in the laboratory SOPs are derived from the source documents for the methods. If method required holding times or preservation requirements are not met, the reports will 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.

22.5 Sample Aliquots / Subsampling

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 need consideration when sub-sampling for sample preparation. It is the laboratory's responsibility to take a representative subsample or aliquot of the sample provided for analysis.

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.

Guidelines on taking sample aliquots & subsampling are located in test method SOPs.

SECTION 23. HANDLING OF SAMPLES

Sample management procedures at the laboratory ensure that sample integrity and custody are maintained and documented from sampling/receipt through disposal.

23.1 Chain of Custody (COC)

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.

23.1.1 Field Documentation

The information the sampler needs to provide at the time of sampling on the container label is:

- Sample identification
- Date and time
- Preservative

During the sampling process, the COC form is completed and must be legible (see Figure 23-1). This form should include information such as:

- Client name, address, phone number and fax number (if available)
- Project name and/or number
- The sample identification
- Date, time and location of sampling
- Sample collectors name
- The matrix description
- The container description
- The total number of each type of container
- Preservatives used
- Analysis requested
- Requested turnaround time (TAT)
- Any special instructions
- Purchase Order number or billing information (e.g. quote number) if available
- The date and time that each person received or relinquished the sample(s), including their signed name.

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 that 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 (Fed-Ex, 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 receipt from the courier is stored in log-in by date; it lists all receipts each date.

23.1.2 Legal / Evidentiary Chain-of-Custody

If the client requests legal COC sample management personnel will initiate an internal COC for laboratory use by analysts and a sample disposal record.

23.2 Sample Receipt

Samples are received at the laboratory by designated sample receiving personnel and a unique laboratory project identification number is assigned. Each sample container shall 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.

23.2.1 Laboratory Receipt

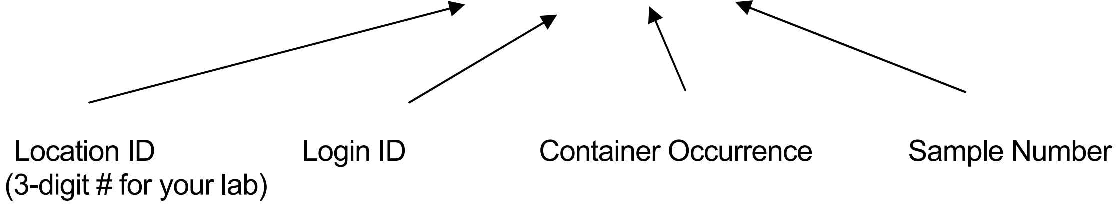
When samples arrive at the laboratory, sample receiving personnel inspect the coolers and samples. The integrity of each sample must be determined by comparing sample labels or tags with the COC and by visual checks of the container for possible damage. Any non-conformance, irregularity, or compromised sample receipt must be documented] and brought to the immediate attention of the client. The COC, shipping documents, documentation of any non-conformance, irregularity, or compromised sample receipt, record of client contact, and resulting instructions become part of the project record.

23.2.1.1 Unique Sample Identification

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 anytime. This system includes identification for all samples, subsamples and subsequent extracts and/or digestates.

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



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.

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

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.

With this system, a client sample can literally be tracked throughout the laboratory in every step from receipt to disposal.

23.3 Sample Acceptance Policy

The laboratory has a written sample acceptance policy (Figure 23-2) that clearly outlines the circumstances under which samples shall be accepted or rejected. These include:

- a complete COC;
- samples must be properly labeled;
- proper sample containers with adequate volume for the analysis (Sampling Guide) and necessary QC;
- samples must be preserved according to the requirements of the requested analytical method (Sampling Guide);
- sample holding times must be adhered to (Sampling Guide);
- the project manager will be notified if any sample is received in damaged condition.

Data from samples which do not meet these criteria are flagged and the nature of the variation from policy is defined. A copy of the sample acceptance policy is provided to each client prior to shipment of samples.

23.3.1 After inspecting the samples, the sample receiving personnel sign and date the COC form, make any necessary notes of the samples' conditions and store them in appropriate refrigerators or storage locations.

23.3.2 Any deviations from these checks that question the suitability of the sample for analysis, or incomplete documentation as to the tests required will be resolved by consultation with the client. If the sample acceptance policy criteria are not met, the laboratory shall either:

- Retain all correspondence and/or records of communications with the client regarding the disposition of rejected samples, or

- Fully document any decision to proceed with sample analysis that does not meet sample acceptance criteria.

Once sample acceptance is verified, the samples are logged into the LIMS according to laboratory SOP BR-SM-001.

23.4 Sample Storage

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. 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.

To ensure the integrity of the samples during storage, refrigerator blanks are maintained in the volatile sample refrigerators and analyzed weekly.

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 until disposal.

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.

23.5 Hazardous Samples and Foreign Soils

To minimize exposure to personnel and to avoid potential accidents, hazardous and foreign soil samples are stored in an isolated area designated for hazardous waste only. For any sample that is known to be hazardous at the time of receipt or, if after completion of analysis the result exceeds the acceptable regulatory levels, a Hazardous Sample Notice must be completed by the analyst. This form may be completed by Sample Control, Project Managers, or analysts and must be attached to the report. The sample itself is clearly marked with a red stamp, stamped on the sample label reading “HAZARDOUS” or “FOREIGN SOIL” and placed in a colored and/or marked bag to easily identify the sample. The date, log number, lab sample number, and the result or brief description of the hazard are all written on the Hazardous & Foreign Soil Sample Notice. A copy of the form must be included with the original COC and Work Order and the original must be given to the Sample Control Custodian. Analysts will notify Sample Control of any sample determined to be hazardous after completion of analysis by completing a Hazardous Sample Notice. All hazardous samples are either returned to the client or disposed of appropriately through a hazardous waste disposal firm that lab-packs all hazardous samples and removes them from the laboratory.

23.6 Sample Shipping

In the event that 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 (see Note). 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.

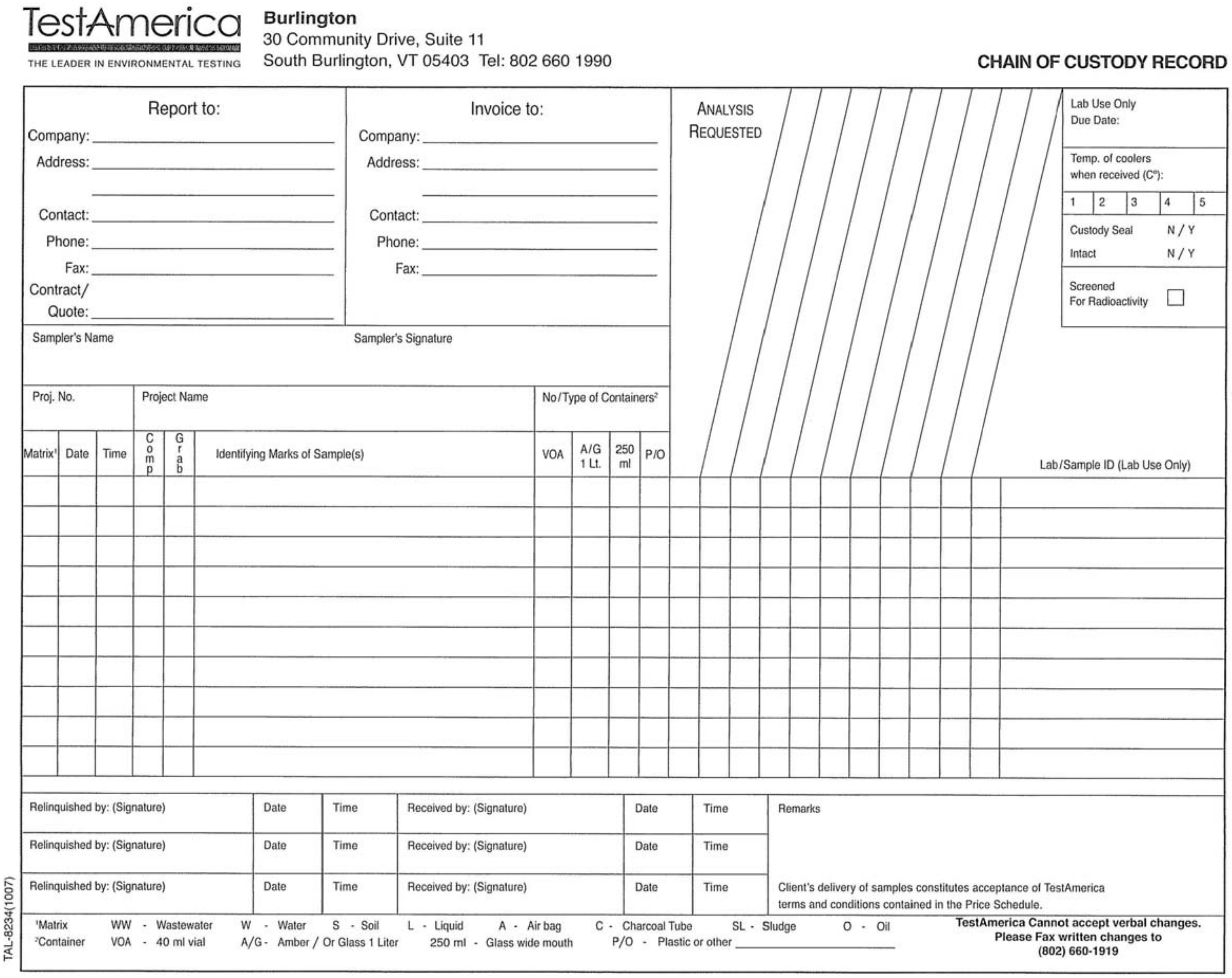
Note: If a client does not request trip blank analysis on the COC or other paperwork, the laboratory will not analyze the trip blanks that were supplied. However, in the interest of good client service, the laboratory will advise the client at the time of sample receipt that it was noted that they did 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.

23.7 Sample Disposal

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: BR-EH-001) 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.

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's 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), names of individuals who conducted the arrangements and physically completed the task. The laboratory will remove or deface sample labels prior to disposal unless this is accomplished through the disposal method (e.g., samples are incinerated). A Waste Disposal Record should be completed.

Figure 23-1. Example: Chain of Custody (COC)



TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING

Burlington
30 Community Drive, Suite 11
South Burlington, VT 05403 Tel: 802 660 1990

CHAIN OF CUSTODY RECORD

Report to:
Company: ______
Address: ______
______
Contact: ______
Phone: ______
Fax: ______
Contract/ Quote: ______

Invoice to:
Company: ______
Address: ______
______
Contact: ______
Phone: ______
Fax: ______

ANALYSIS REQUESTED

Lab Use Only
Due Date:

Temp. of coolers when received (C°):

1	2	3	4	5

Custody Seal N / Y
Intact N / Y
Screened For Radioactivity ☐

Sampler's Name
Sampler's Signature

Proj. No.
Project Name
No/Type of Containers[2]

Matrix[1]	Date	Time	Comp	Grab	Identifying Marks of Sample(s)	VOA	A/G 1 Lt.	250 ml	P/O												Lab/Sample ID (Lab Use Only)

Relinquished by: (Signature)	Date	Time	Received by: (Signature)	Date	Time	Remarks
Relinquished by: (Signature)	Date	Time	Received by: (Signature)	Date	Time	
Relinquished by: (Signature)	Date	Time	Received by: (Signature)	Date	Time	Client's delivery of samples constitutes acceptance of TestAmerica terms and conditions contained in the Price Schedule.

[1] Matrix WW - Wastewater W - Water S - Soil L - Liquid A - Air bag C - Charcoal Tube SL - Sludge O - Oil

[2] Container VOA - 40 ml vial A/G - Amber / Or Glass 1 Liter 250 ml - Glass wide mouth P/O - Plastic or other ______

TestAmerica Cannot accept verbal changes. Please Fax written changes to (802) 660-1919

TAL-8234(1007)

Figure 23-2. Example: Sample Acceptance Policy

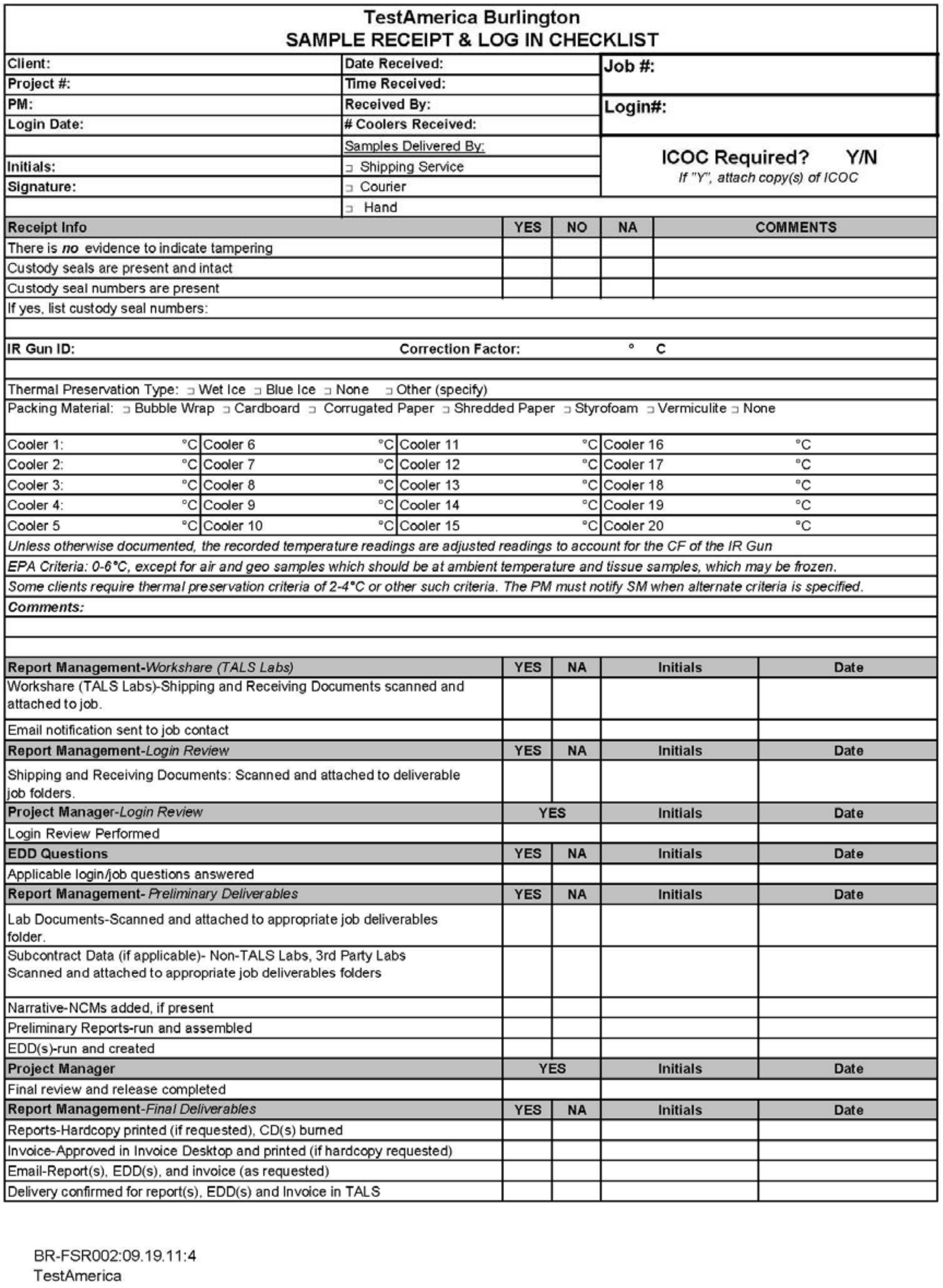
The receipt of samples is acknowledged on the chain of custody (COC) form with the signature and date/time of the sample custodian. The condition of samples upon receipt is documented on checklists designated for this purpose. Any deficiencies identified during sample receipt are recorded and communicated to the laboratory project manager (PM), who will contact the client and fully document any decision to proceed with analysis in the project record. Consultation with the client should be immediate and timely (next business day or as specified in the project plan). Correspondence records and/or records of conversations concerning the decision to proceed with analysis and/or the disposition of rejected samples is maintained in the project record, and should be maintained in association with the sample receipt checklist. All data associated with samples that did not meet the sample acceptance criteria must be qualified with a Non-Conformance Report (NCR) and/or noted in the project narrative that accompanies the final test report.

Sample receipt is considered deficient when the following conditions are observed:

- Shipping cooler and/or samples are received outside the temperature specification
- Sample bottles are received broken or leaking
- Samples are received beyond holding time
- Samples are received without the appropriate preservation
- Samples are not received in appropriate containers
- Chain of Custody does not match the samples received
- Chain of Custody was not received or is incomplete*
- Custody seals are broken
- Evidence of tampering with the cooler and/or samples
- Headspace in 40mL or 22 mL VOA vials
- Seepage of extraneous water or other material into the samples
- Inadequate sample volume
- Illegible, impermanent ink, or non-unique sample labeling
- One or more coolers missing from a multi parcel shipment
- Shipping container is damaged

**Complete documentation shall include sample identification, the location date/time of collection, collector’s name, preservation type, sample type and any special remarks concerning the sample.*

Figure 23-3. Example: Cooler Receipt Form



TestAmerica Burlington
SAMPLE RECEIPT & LOG IN CHECKLIST

Client:	**Date Received:**	**Job #:**
Project #:	**Time Received:**	
PM:	**Received By:**	**Login#:**
Login Date:	**# Coolers Received:**	
	Samples Delivered By:	**ICOC Required? Y/N** *If "Y", attach copy(s) of ICOC*
Initials:	☐ Shipping Service	
Signature:	☐ Courier	
	☐ Hand	

Receipt Info	**YES**	**NO**	**NA**	**COMMENTS**
There is ***no*** evidence to indicate tampering				
Custody seals are present and intact				
Custody seal numbers are present				

If yes, list custody seal numbers:

IR Gun ID: **Correction Factor:** ° C

Thermal Preservation Type: ☐ Wet Ice ☐ Blue Ice ☐ None ☐ Other (specify)

Packing Material: ☐ Bubble Wrap ☐ Cardboard ☐ Corrugated Paper ☐ Shredded Paper ☐ Styrofoam ☐ Vermiculite ☐ None

Cooler 1: °C	Cooler 6 °C	Cooler 11 °C	Cooler 16 °C
Cooler 2: °C	Cooler 7 °C	Cooler 12 °C	Cooler 17 °C
Cooler 3: °C	Cooler 8 °C	Cooler 13 °C	Cooler 18 °C
Cooler 4: °C	Cooler 9 °C	Cooler 14 °C	Cooler 19 °C
Cooler 5 °C	Cooler 10 °C	Cooler 15 °C	Cooler 20 °C

Unless otherwise documented, the recorded temperature readings are adjusted readings to account for the CF of the IR Gun

EPA Criteria: 0-6°C, except for air and geo samples which should be at ambient temperature and tissue samples, which may be frozen.

Some clients require thermal preservation criteria of 2-4°C or other such criteria. The PM must notify SM when alternate criteria is specified.

Comments:

Report Management-*Workshare (TALS Labs)*	**YES**	**NA**	**Initials**	**Date**
Workshare (TALS Labs)-Shipping and Receiving Documents scanned and attached to job.				
Email notification sent to job contact				
Report Management-*Login Review*	**YES**	**NA**	**Initials**	**Date**
Shipping and Receiving Documents: Scanned and attached to deliverable job folders.				
Project Manager-*Login Review*	**YES**		**Initials**	**Date**
Login Review Performed				
EDD Questions	**YES**	**NA**	**Initials**	**Date**
Applicable login/job questions answered				
Report Management- *Preliminary Deliverables*	**YES**	**NA**	**Initials**	**Date**
Lab Documents-Scanned and attached to appropriate job deliverables folder.				
Subcontract Data (if applicable)- Non-TALS Labs, 3rd Party Labs Scanned and attached to appropriate job deliverables folders				
Narrative-NCMs added, if present				
Preliminary Reports-run and assembled				
EDD(s)-run and created				
Project Manager	**YES**		**Initials**	**Date**
Final review and release completed				
Report Management-*Final Deliverables*	**YES**	**NA**	**Initials**	**Date**
Reports-Hardcopy printed (if requested), CD(s) burned				
Invoice-Approved in Invoice Desktop and printed (if hardcopy requested)				
Email-Report(s), EDD(s), and invoice (as requested)				
Delivery confirmed for report(s), EDD(s) and Invoice in TALS				

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SECTION 24. ASSURING THE QUALITY OF TEST RESULTS

24.1 Overview

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. 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. 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

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 Blank (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.).
	Reanalyze or qualify associated sample results when the concentration of a targeted analyte in the blank is at or above the reporting limit as established by the method or by regulation, AND is greater than 1/10 of the amount measured in the sample.
Calibration Blanks	are prepared and analyzed along with calibration standards where applicable. 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.
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.

Table 24-1. Example – Negative Controls

Control Type	Details
Trip Blank [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

[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."

Evaluation criteria and corrective action for these controls are defined in the specific standard operating procedure for each analysis.

24.4 Positive Controls

Control samples (e.g., QC indicators) are analyzed with each batch of samples to evaluate data based upon (1) Method Performance (Laboratory Control Sample (LCS) or Blank Spike (BS)), which entails both the preparation and measurement steps; and (2) Matrix Effects (Matrix Spike (MS) (Matrix spikes are not applicable to air) or Sample Duplicate (MD, DUP), which evaluates field sampling accuracy, precision, representativeness, interferences, and the effect of the matrix on the method performed. 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.

24.4.1 Method Performance Control - Laboratory Control Sample (LCS)

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.

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.

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.).

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 1 for each batch of samples; not to exceed 20 environmental samples.

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.

- For methods that have 1-10 target analytes, spike all components.

- For methods that include 11-20 target analytes, spike at least 10 or 80%, whichever is greater.
- For methods with more than 20 target analytes, spike at least 16 components.

- Exception: Due to analyte incompatibility in pesticides, Toxaphene and Chlordane are only spiked at client request based on specific project needs.

- 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.

24.5 Sample Matrix Controls

Table 24-2. Sample Matrix Control

Control Type	Details	
Matrix Spikes (MS)	Use	used to assess the effect sample matrix of the spiked sample has on the precision and accuracy of the results generated by the method used;

Table 24-2. Sample Matrix Control

Control Type	Details	
	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 acceptance 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.
Duplicates[2]	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.

24.6 Acceptance Criteria (Control Limits)

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.

Once control limits have been established, they are verified, reviewed, and updated when necessary 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.

Laboratory generated % 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).

- 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).

- 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) can 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.

- 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.

24.6.1 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.

24.6.2 A 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 acceptance limits may be determined as out of control and should be reanalyzed if possible. If reanalysis 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 acceptance limits. Sample results may be qualified and reported without reanalysis if:

- The analyte results are below the reporting limit and the LCS is above the upper control limit.

- If the analytical results are above the relevant regulatory limit and the LCS is below the lower control limit.

24.6.3 If the MS/MSDs do not meet acceptance 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 reanalyzed 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.

24.6.4 If a surrogate standard falls outside the acceptance limits, if there is not obvious chromatographic matrix interference, reanalyze 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 reanalysis meets surrogate recovery criteria, the second run is reported (or both are reported if requested by the client).

24.7 Additonal Procedures to Assure Quality Control

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).

A discussion regarding MDLs, Limit of Detection (LOD) and Limit of Quantitation (LOQ) can be found in Section 19.

- Use of formulae to reduce data is discussed in the method SOPs and in Section 20.
- Selection of appropriate reagents and standards is included in Section 9 and 21.
- A discussion on selectivity of the test is included in Section 5.
- Constant and consistent test conditions are discussed in Section 18.
- The laboratories sample acceptance policy is included in Section 23.

SECTION 25. REPORTING RESULTS

25.1 Overview

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 conflict between client requests and laboratory ethics or regulatory requirements, the laboratory's ethical and legal requirements are paramount, and the laboratory will work with the client during project set up to develop an acceptable solution. Refer to Section 7.

The format of each report type is specific to the client or regulatory program and is therefore not included in the QAM.

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. Review of reported data is included in Section 19.

25.2 Test Reports

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 on laboratory letterhead, reviewed, and signed by the appropriate project manager. At a minimum, the standard laboratory report shall contain the following information:

25.2.1 A report title (e.g. Analytical Report For Samples) with a “sample results” column header.

25.2.2 Each report cover page printed on company letterhead, which includes the laboratory name, address and telephone number.

25.2.3 A unique identification of the report 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.

25.2.4 A copy of the chain of custody (COC).

- Any COCs involved with Subcontracting are included.

25.2.5 The name and address of client and a project name/number, if applicable.

25.2.6 Client project manager or other contact

25.2.7 Description and unambiguous identification of the tested sample(s) including the client identification code.

25.2.8 Date of receipt of sample, date and time of collection, and date(s) of test preparation and performance, and time of preparation or analysis if the required holding time for either activity is less than or equal to 72 hours.

25.2.9 Date reported or date of revision, if applicable.

25.2.10 Method of analysis including method code (EPA, Standard Methods, etc).

25.2.11 Practical quantitation limits or reporting limit.

25.2.12 Method detection limits (if requested)

25.2.13 Definition of Data qualifiers and reporting acronyms (e.g. ND).

25.2.14 Sample results.

25.2.15 QC data consisting of method blank, surrogate, LCS, and MS/MSD recoveries and control limits.

25.2.16 Condition of samples at receipt including temperature. This may be accomplished in a narrative or by attaching sample login sheets (Refer to Sec. 25.2.4 – Item 3 regarding additional addenda).

25.2.17 A statement to the effect that the results relate only to the items tested and the sample as received by the laboratory.

25.2.18 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.

25.2.19 When NELAC accreditation is required, the lab shall certify that the test results meet all requirements of TNI Standard or provide reasons and/or justification if they do not.

25.2.20 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.

25.2.21 When soil samples are analyzed, a specific identification as to whether soils are reported on a “wet weight” or “dry weight” basis.

25.2.22 Appropriate laboratory certification number for the state of origin of the sample, if applicable.

25.2.23 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.

25.2.24 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.

25.2.28 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 (No. CA-I-P-002) for details on internally applying electronic signatures of approval.

25.3 Reporting Level or Report Type

The laboratory routinely offers four levels of quality control reporting.

- Level I is a report with the features described in Section 25.2 above except QC summary information is not included.
- Level II is a Level I report plus QC summary information.
- Level III contains all the information supplied in Level II, but presented on CLP-like summary forms, and relevant calibration information. No raw data is provided.
- Level IV is the same as Level III with the addition of all raw supporting data.

The format of each report type is specific to the client or regulatory program and is therefore not included in the QAM. The reporting specifications for CLP contract samples must comply with the specifications for CSF organization, preparation and review as specified in the SOW. Procedures for preparation of the CSF are provided in laboratory SOP BR-RM-001.

25.3.1 Electronic Data Deliverables (EDDs)

EDDs are routinely offered as part of TestAmerica’s services. TestAmerica Burlington offers a variety of EDD formats including Environmental Restoration Information Management System (ERPIMS), New Agency Standard (NAS), Format A, Excel, Dbase, GISKEY, and Text Files.

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.

EDDs shall 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.

25.4 Supplemental Information for Test

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.

Numeric results with values outside of the calibration range, either high or low are qualified as ‘estimated’.

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 sample acceptance requirements such as improper container, holding time, or temperature.

Where applicable, a statement on the estimated uncertainty of measurements; information on uncertainty is needed when a client’s instructions so require.

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 will 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.

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.

25.5 Environmental Testing Obtained From Subcontractors

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 on Subcontracting (SOP No. CA-L-S-002).

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 TestAmerica are reported to the client on the subcontract laboratory’s original report stationary and the report includes any accompanying documentation.

25.6 Client Confidentiality

In situations involving the transmission of environmental test results by telephone, facsimile or other electronic means, client confidentiality must be maintained.

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.

25.6.1 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:

This material is intended only for the use of the individual(s) or entity to whom it is addressed, and may contain information that is privileged and confidential. If you are not the intended recipient, or the employee or agent responsible for delivering this material 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 us immediately by telephone at the 1-800-765-0980 (or for e-mails: please notify us immediately by e-mail or by phone (1-800-765-0980) and delete this material from any computer).

25.7 Format of Reports

The format of reports is designed to accommodate each type of environmental test carried out and to minimize the possibility of misunderstanding or misuse.

25.8 Amendments to Test Reports

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).

The revised report is retained on the Archive data server, as is the original report. The revised report will have the word "revised" or "amended" next to the date rather than the word "reported".

When the report is re-issued, a notation of “report re-issue “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 re-issue and a reference back to the last final report generated. *For Example*: *Report was revised on 11/3/08 to include toluene in sample NQA1504 per client’s request. This final report replaces the final report generated on 10/27/08 at 10:47am.*

25.9 Policies on Client Requests for Amendments

25.9.1 Policy on Data Omissions or Reporting Limit Increases

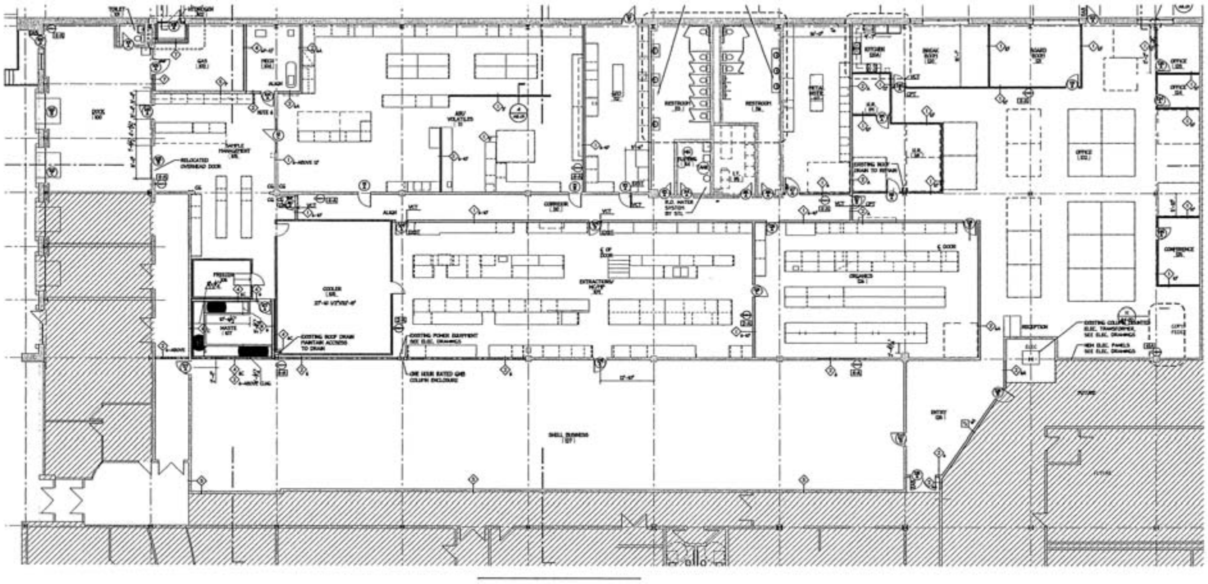
Fundamentally, our policy is simply to not omit previously reported results (including data qualifiers) or to not raise reporting limits and report sample results as ND. This policy has few exceptions. Exceptions are:

- Laboratory error.
- Sample identification is indeterminate (confusion between COC and sample labels).
- An incorrect analysis (not analyte) was requested (e.g., COC lists 8315 but client wanted 8310). A written request for the change is required.
- Incorrect limits reported based on regulatory requirements.
- 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.

25.9.2 Multiple Reports

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



Appendix 2. Glossary/Acronyms (EL-V1M2 Sec. 3.1)

Glossary:

Acceptance Criteria: Specified limits placed on characteristics of an item, process, or service defined in requirement documents. (ASQC)

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 that 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 (1) to twenty (20) environmental samples of the same quality systems 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 twenty-four (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 twenty (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. (ASQC)

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 ~~r~~elationship 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. (TNI)

Chain of Custody (COC) Form: 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. 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. (TNI)

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. (ASQC)

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: hose matrix, technology/method, and analyte combinations for which the NELAP 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 shall 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 shall 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 reliably 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 shall be used:

Aqueous: Any aqueous sample excluded from the definition of Drinking Water or Saline/Estuarine. 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 shall 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 & 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 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 aboratory 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, ~~product~~ 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: Material or substance one or more properties of which are sufficiently homogeneous and well established to be used for the calibration of an apparatus, the assessment of a measurement method, or for assigning values to materials. (TNI)

Reference Standard: Standard used for the calibration of working measurement standards in a given organization or a given location. (TNI)

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 r^2) 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, r^2 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. (TNI)

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 for 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 shall 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)

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:

CAR – Corrective Action Report
CCV – Continuing Calibration Verification
CF – Calibration Factor
CFR – Code of Federal Regulations
COC – Chain of Custody
DOC – Demonstration of Capability
DQO – Data Quality Objectives
DUP - Duplicate
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
ICV – Initial Calibration Verification
IDL – Instrument Detection Limit
IH – Industrial Hygiene
IS – Internal Standard
LCS – Laboratory Control Sample
LCSD – Laboratory Control Sample Duplicate
LIMS – Laboratory Information Management System
LOD – Limit of Detection
LOQ – Limit of Quantitation
MDL – Method Detection Limit
MDLV – MDL Verification Check Standard
MRL – Method Reporting Limit Check Standard
MS – Matrix Spike
MSD – Matrix Spike Duplicate
MSDS - Material Safety Data Sheet
NELAC - National Environmental Laboratory Accreditation Conference
NELAP - National Environmental Laboratory Accreditation Program
PT – Performance Testing
TNI – The NELAC Institute
QAM – Quality Assurance Manual
QA/QC – Quality Assurance / Quality Control
QAPP – Quality Assurance Project Plan
RF – Response Factor
RPD – Relative Percent Difference
RSD – Relative Standard Deviation
SD – Standard Deviation
SOP – Standard Operating Procedure
TAT – Turn-Around-Time
VOA – Volatiles
VOC – Volatile Organic Compound

Appendix 3. Laboratory Certifications, Accreditations, Validations

TestAmerica Burlington maintains accreditation, certifications and approvals with numerous state and national entities. At the time of this QA Manual revision, the laboratory has accreditation/certification/licensing with the following organizations:

Lab ID	Program	Program Type	Authority
NA	Delaware DNREC		Delaware
ADE-1492	DoD ELAP	DoD	L-A-B
200610	NELAC	Secondary AB	New Hampshire
VT972	NELAC	Primary AB	New Jersey
10391	NELAC	Secondary AB	New York
68-00489	NELAC	Secondary AB	Pennsylvania
E87467	NELAC	Secondary AB	Florida
176292	NELAC	Secondary AB	Louisiana
PH-0751	State Program		Connecticut
VT00008	State Program		Maine
050-999-436	State Program		Minnesota
LAO00298	State Program		Rhode Island
VT-4000	State Program		Vermont
P330-11-00093	USDA		USDA

The certificates and parameter lists are available upon request from a laboratory representative. A complete list of analytical capabilities may be found on the company’s web site, the laboratory’s public server or from a representative of the laboratory.

Title: Volatile Organic Compounds by GC/MS SW-846 8260C, SW-846 5030C, SW-846 5035 and SW-846 5035A

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Approval Date: September 23, 2012

Facility Distribution No. Electronic **Distributed To: Facility Intranet**

The controlled copy of this SOP is the PDF copy of the SOP that is posted to the laboratory's SOP Directory. Printed copies of this SOP or electronic copies of this SOP distributed outside the facility are considered uncontrolled.

1.0 Scope and Application

This SOP describes the laboratory procedure for the determination of volatile organic compounds (VOCs) by GC/MS.

This SOP is applicable to the procedure for the determinative method. Sample preparation and screen procedures are described in laboratory SOP BR-MV-007.

1.1 Analytes, Matrix(s), and Reporting Limits

This procedure may be used for a variety of matrices including: water, soil, sediment, and TCLP leachates.

The laboratory's list of analytes that can be determined by this SOP is provided in Attachment 1 along with the compound's associated reporting limit (RL). The RLs listed represent those that can be achieved in a blank matrix at 100% dry weight. RLs associated with field samples will vary based on sample matrix, analyte concentration, co-extracted interferences and the percent moisture of sample. The RL for methanol extracts (MeOH) is based on a preparation factor of 5 g of sample to 10 mL of methanol.

2.0 Summary of Method

Compounds are introduced into the GC/MS system by purge-and-trap (SW-846 Method 5030C) or closed-system purge-and-trap (SW-846 5035, SW-846 5035A). The VOCs are introduced directly to a capillary column where a temperature program is used to separate the analytes which are then detected with a mass spectrometer interfaced to the gas chromatograph (GC/MS).

This procedure is based on the following reference methods:

- SW-846 Method 8260C, Revision 3, August 2006.
- SW-846 Method 5030C, Revision 3, May 2003.
- SW-846 Method 5035, Revision 0, December 1996.
- SW-846 Method 5035A, Draft Revision 1, July 2002.

If the laboratory has modified its procedure from the reference method, a list of method modifications will be provided in Section 16.0.

3.0 Definitions

A list of terms and definitions are provided in Appendix A.

4.0 Interferences

Major contaminant sources are volatile materials in the laboratory and impurities in the inert purging gas and in the sorbent trap. The use of Teflon tubing, Teflon thread sealants, or flow controllers with rubber components in the purging device should be avoided since such materials out-gas organic compounds which will be concentrated in the trap during the purge operation. Analyses of laboratory reagent blanks provide information about the presence of contaminants. Subtracting blank values from sample results is not permitted.

Interfering contamination may occur when a sample containing low concentrations of volatile organic compounds is analyzed immediately after a sample containing relatively high concentrations of volatile organic compounds. The auto-sampler utilizes a single purge vessel that is automatically rinsed between analyses. After analysis of a sample containing high concentrations of volatile organic compounds, one or more laboratory reagent blanks may be analyzed to check for carry-over.

The analytical and sample storage area should be isolated from all atmospheric sources of methylene chloride; otherwise, random background levels will result. Since methylene chloride will permeate Teflon tubing, all GC carrier gas lines and purge gas plumbing should be constructed of stainless steel or copper tubing. Laboratory worker's clothing should be cleaned frequently since clothing previously exposed to methylene chloride fumes during common extraction procedures can contribute to sample contamination. Extraction laboratory personnel should not enter the volatile analytical laboratory.

Traces of ketones, methylene chloride, and some other organic solvents can be present even in the highest purity methanol. This is another potential source of contamination, and should be assessed before standards are prepared in the methanol.

5.0 Safety

Employees must abide by the policies and procedures in the Corporate Environmental Health and Safety Manual (CW-E-M-001) and this document. This procedure may involve hazardous material, operations and equipment. This SOP does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of the method to follow appropriate safety, waste disposal and health practices under the assumption that all samples and reagents are potentially hazardous. Safety glasses, gloves, lab coats and closed-toe, nonabsorbent shoes are a minimum.

5.1 Specific Safety Concerns or Requirements

The gas chromatograph and mass spectrometer contain zones that have elevated temperatures. The analyst needs to be aware of the locations of those zones, and must cool them to room temperature prior to working on them.

The mass spectrometer is under deep vacuum. The mass spectrometer must be brought to atmospheric pressure prior to working on the source. There are areas of high voltage in both the gas chromatograph and the mass spectrometer. Depending on the type of work involved, either turn the power to the instrument off, or disconnect it from its source of power.

The following analytes have been tentatively classified as known or suspected human or mammalian carcinogens: benzene, carbon tetrachloride, 1,4-dichlorobenzene, 1,2-dichlorethane, hexachlorobutadiene, 1,1,2,2-tetrachloroethane, 1,1,2-trichloroethane, chloroform, 1,2-dibromoethane, tetrachloroethene, trichloroethene, and vinyl chloride.

5.2 Primary Materials Used

Table 2 lists those materials used in this procedure that have a serious or significant hazard rating along with the exposure limits and primary hazards associated with that material as identified in the MSDS. **NOTE: This list does not include all materials used in the method.** A complete list of materials used in the method can be found in the reagents and materials section.

Employees must review the information in the MSDS for each material before using it for the first time or when there are major changes to the MSDS.

6.0 Equipment and Supplies

Catalog numbers listed in this SOP are subject to change. Analysts are instructed to ensure equipment used meets the specification of this SOP.

6.1 Miscellaneous

- 44 mL VOA Vials. ESS or equivalent.
- 1-5 mL Mini-Inert Vials with Teflon Lined Screw Caps. Restek brand or equivalent.
- Gas-Tight Syringe(s) 250 uL-10 mL, Hamilton or equivalent.

6.2 Purge and Trap

- Purge & trap Device: Tekmar LCS 2000, Tekmar Velocity, EST Encon Evolution, or equivalent.
- Autosampler: EST Archon, EST Centurion or equivalent.
- Trap: Supelco, VOCARB 3000 trap or equivalent

6.3 Instrumentation

- Gas Chromatograph: Hewlett-Packard 5890 Series II and 6890
- Mass Spectrometer: Hewlett-Packard 5971 MSD, Hewlett-Packard 5973 MSD
- Primary Column: Fused silica capillary column, 75 m x 0.53 mm x 3.0 um: J&W DB624 or equivalent. J&W DB624 25m x 0.200mm x 1.12um or equivalent

6.4 Software

- GC/MS Acquisition Platform - Hewlett-Packard ChemStation.
- Data Processing - Hewlett-Packard 9000-series computers, an HP9000 D250, HP 9000 K200 / HP-UX 10.20 and Target V3.5, TestAmerica Chrom and TestAmerica LIMS (TALS).

7.0 Reagents and Standards

7.1 Reagents

- Methanol (CH_3OH), Purge & Trap Quality: Company Approved Vendor: Mallinckrodt-Baker P&T Grade methanol or equivalent.

VOA-Free Reagent Water: Boil RO water for 1 hour then purge with helium.

7.2 Standards

Purchase stock standard solutions from commercial vendors and from these prepare calibration and working standards by diluting a known volume of stock standard in an appropriate solvent to the final volume needed to achieve the desired concentration. The recommended formulation for each standard used in this procedure is provided in Appendix B along with the recommended source materials, expiration dates and storage conditions.

8.0 Sample Collection, Preservation, Shipment and Storage

The laboratory does not perform sample collection so these procedures are not included in this SOP.

Listed below are the laboratory recommended minimum sample size for collection and the method required preservation and holding time requirements:

Matrix	Sample Container	Minimum Sample Size	Preservation	Holding Time	Reference
Water	Glass	40 mL (3)	See Note	See Table 2	SW-846
Soil	Various	150 g	See Note	See Table 2	SW-846

The laboratory requires a minimum sample volume of 3 x 40 mL vials for waters and 3 x 5.0 g aliquots for soils. The laboratory recommends that each water sample be collected in triplicate to ensure sufficient volume for screen analysis and pH measurement, and reserve. The container type for soils depends on the collection method used.

Note: The SW-846 methods include several different types of sample preservation. The most common preservation techniques are to acidify water samples to a pH <2 with hydrochloric acid (HCl) and to preserve soils with sodium bisulfate. Both matrices after collection should be cooled to 4± 2ºC and kept at this temperature until analysis. Adjusting the pH of a soil, sediment or solid waste sample may cause interferences and samples that contain carbonates should not be acidified due to effervescence which may cause a loss of VOCs. Some compounds, such as olefins, ketones, esters, ethers and sulfides may react under conditions of low pH and then may no longer represent the actual sample material. Acidification can also lead to losses of highly reactive compounds such as 2-chloroethylvinylether and acidification of certain soils with sodium bisulfate may produce a false positive for acetone. To counter these interferences, new techniques for preserving samples as described in SW-846 Method 5035A. A summary of the various preservation techniques used by the laboratory and associated holding times is provided Table 3 and also in laboratory SOP BR-MV-007. The actual preservation technique used for individual projects should be selected based on regulatory requirements and project data quality objectives.

Unless otherwise specified by client or regulatory program, after analysis, samples and extracts are retained for a minimum of 30 days after provision of the project report and then disposed of in accordance with applicable regulations.

9.0 Quality Control

9.1 Sample QC

The laboratory prepares the following quality control samples with each analytical window of samples.

QC Item	Frequency	Acceptance Criteria
Method Blank (MB)	1 in 20 or fewer samples	See Table 4
Laboratory Control Sample (LCS)	1 in 20 or fewer samples	See Table 4
Matrix Spike(s) (MS/MSD)	Client Request	See Table 4
Sample Duplicate	Client Request	See Table 4

The composition of the MB and the LCS are matched to the matrix of the samples for which they are associated. For instance, when soil samples are analyzed medium level, a MB and LCS comprised of methanol will be analyzed with the samples and these QC samples will be associated with the samples for reporting purposes.

Surrogate standards are added to all field and QC samples prior to analysis to assess the effect of the sample matrix on the accuracy of the method in the specific sample matrix.

Internal standards are added to all field and QC samples prior to analysis.

9.2 Instrument QC

The following instrument QC is performed:

QC Item	Frequency	Acceptance Criteria
Tune Standard (BFB)	Prior to calibration and every 12 hours	See Table 3
5- Point Initial Calibration (ICAL)	Prior to initial sample analysis; when ICV or CCV fail	See Table 4
Second Source Calibration Verification (ICV)	Once after each ICAL	See Table 4
Continuing Calibration Verification (CCV)	Daily, every 12 hours after BFB	See Table 4

10.0 Procedure

10.1 Instrument Operating Conditions

10.1.1 Archon Auto Sampler

Water and Medium Level Soils (MeOH): Program the autosampler to pull 5 mL of sample from each vial. The autosampler is designed to pierce the vial septa with the water side needle and pull the aliquot using vacuum after which the sample is transferred to the purge vessel. After each sample, the autosampler flushes the sample pathway with VOA free reagent water.

Low Level Soils: Program the autosampler to place the vial in position. When in position the autosampler adds 5 mL of VOA free water to the sample then preheats the sample to 40℃ for 1 minute. The sample is purged with helium while simultaneously being mixed with a magnetic stir bar. After each sample, the autosampler flushes the sample pathway with VOA free reagent water.

10.1.2 GC/MS

Set the GC/MS to acquire and store data over the mass range of 35-300 atomic mass units (amu) with a total cycle time (including scan overhead time) of one second as generated from a nominal ionization energy of 70 electron volts. Adjust the cycle time to measure five or more spectra during the elution of each GC peak. Use a multi-stage temperature ramp to separate the components of interest for this analysis.

A typical GC temperature program is described below:

Initial temperature:	40°C
Initial time:	4 min.
Ramp1:	7°C/min. to 100° C.
Ramp2:	4.2°C/min. to 120°C, hold for 0 min.
Ramp3:	28°C/min. to 220°C, hold for 2.7 min.
Carrier Gas:	Helium

The conditions listed above may be changed however once the operating conditions are established for the initial calibration, the same operating conditions must be used for the subsequent analysis of instrument performance check standards, QC and field samples.

10.2 Retention Time

Establish component retention times from the most recent calibration standard plus or minus 0.06 RRT units (RRT)

10.3 Instrument Calibration

10.3.1 Tune Standard

Prior to initial calibration (ICAL) and every 12 hours check the tuning of the instrument with analysis of the tune standard, 4-Bromofluorbenzene (BFB).

Prepare the BFB standard solution (25 ug/mL) using the formulation provided in Appendix B.

Manually inject 2 uL of the BFB solution into the GC to yield an on-column concentration of 50ng.

The data processing system acquires and averages three scans (apex scan, scan prior, and scan preceding) and performs background subtraction of the single scan prior to the elution of the BFB.

Evaluate the result. The BFB must meet the ion criteria given in Table 3. If criteria are not met, correct the problem and retune the instrument.

The official start time of the 12-hour analytical window is the time of the BFB injection. All samples must be injected within 12 hours of that time.

10.3.2 Initial Calibration (ICAL)

The instrument must be calibrated with a minimum of five calibration standards for each target analyte at concentrations that span the working range of the method. Repeat initial calibration whenever instrument operating conditions are changed, a new column is installed, when significant instrument maintenance has been performed, and when the result of the CCV indicate the calibration is no longer valid.

The laboratory performs two different calibration schemes for this test method. One calibration is used for water and methanol extracts; the other calibration is used for low level soils.

Prepare the calibration standards using the formulations provided in Appendix B.

Analyze the standards in a sequence using the instructions provided in Section 10.5.

Each of the following criteria must be met for each analyte that is to be reported from the calibration. If criteria are not met, the problem must be corrected and the initial calibration repeated. Samples may not be analyzed against a calibration curve that does not meet the following criteria. All calculations are performed by the data processing system, which is defaulted to RSD for quantification.

1) The %RSD for 90% of analytes must be ≤ 20%.

2) Minimum Response Factor for analytes listed in Attachment 1 must be met.

3) The Relative Retention Time (RRT) for each analyte in each calibration standard must agree within 0.06 RRT units.

4) The RSD for each analyte in the calibration must be less than or equal to 20% in order to use the mean RF for quantification. If this criterion is not met, use linear or weighted linear regression for the analyte that did not meet RSD criterion. To use linear (or weighted linear) use the data processing system to generate a curve of concentration vs. response. The data system calculates the correlation coefficient. The correlation coefficient (r) must be ≥ 0.99. If (r) is not met troubleshoot to determine cause, correct the problem, and repeat initial calibration. Note that the use of linear regression requires a minimum of 5 calibration points. Refer to SW-846 Method 8000B or 8000C for linear regression calculations.

ICAL Criteria Exception(s):

- Individual analytes that do not meet ICAL criteria may be reported from the ICAL when the analyte is not included in the reporting list for individual samples. For example, if a client has a short list of target analytes requested for a set of samples and the calibration passes criteria for each analyte in the client list; the ICAL may be used for these project samples because the ICAL failures do not have an effect on the individual analytes requested. With this exception a TALS nonconformance memo (NCM) is not required.

- Individual analytes that fail ICAL criteria may be reported as estimated values during the time-frame in which corrective action is taking place. If this exception is used; document the ICAL failure for the individual analytes with an NCM. The NCM must be associated to the samples affected. In other words, initiate an NCM for each batch of samples associated to the ICAL instead of an NCM associated to the ICAL batch. To clarify, samples affected means any sample in which the individual analyte that that did not meet ICAL criteria is reported regardless if the analyte is detected. The NCM will alert the project manager to identify the exception in the report narrative and to specify the results for these individual analytes are classified as estimated values. The internal comment tab of the NCM report should include the suspected cause for the ICAL failure and the corrective actions that are underway to correct the problem.

10.3.3 Second Source Calibration Verification (ICV)

Verify the accuracy of the initial calibration by analyzing a second source standard (ICV).

Prepare the ICV standard using the formulations provided in Appendix B. Analyze the ICV following the procedure specified in Section 10.5. Acquire the data and evaluate the result.

The percent recovery for each analyte included in the calibration must be within ± 30% of the expected value. If this criterion is not met, correct the problem and reanalyze the ICV. If the reanalysis of the ICV fails, remake the calibration standards and repeat the initial calibration.

ICV Criteria Exception:

- Individual analytes that fail ICV criteria may be reported as estimated values during the time-frame in which corrective action is taking place. If this exception is used; document the ICV failure for the individual analytes with an NCM. The NCM must be associated to the samples affected. In other words, initiate an NCM for each batch of samples associated to the ICV batch (which should be the same TALS batch as the ICAL) instead of an NCM associated to the batch that includes the ICV. To clarify, samples affected means any sample in which the individual analyte that that did not meet ICV criteria is reported regardless if the analyte is detected. The NCM will alert the project manager to identify the exception in the report narrative and to specify the results for these individual analyte(s) are classified as estimated values. The internal comment tab of the NCM report should include the suspected cause for the ICV failure and the corrective actions that are underway to correct the problem.

If after successful analysis of the ICV, time remains in the 12-hour analytical window samples may be analyzed without analysis of a continuing calibration verification standard (CCV); otherwise a CCV must be performed.

10.3.4 Troubleshooting:

- Chloromethane response can be low if the purge flow is too fast.
- Bromoform response can be low if the purge flow is too slow. Cold spots and/or active sites in the transfer lines may adversely affect response. Response of the quantification ion (m/z 173) is directly affected by the tuning of BFB at ions m/z 174/176. Increasing the m/z 174/176 ratio relative to m/z 95 may improve bromoform response.
- Contaminated transfer lines in purge-and-trap systems and/or active sites in the trap can degrade the response of Tetrachloroethane and 1,1-dichloroethane.
- 2-Chloroethylvinylether response can be drastically affected/suppressed by soil, foam, or other artifacts contaminating the inside of the soil purge needle. It is also susceptible to active sites/contamination anywhere in the helium path from the autosampler (soils) to the injection port on the GC.
- If the response of the later eluting compounds is low, especially with soils, the purge flow may have been reduced by an obstruction in the helium flow path.

- Poor chromatography and response of the gases are often the result of incorrect placement of the column head in the injection port and/or contamination of the first 6-10 inches of the column from samples and small pieces of injection port septum.
- Erratic response of various compounds and unstable calibrations can be the result of a worn out/contaminated purge trap. Variable matrices such as tissues, soils and moderately foamy samples can be the cause. Samples high in late eluting hydrocarbons or sulfur dioxide will also degrade the trap.

10.3.5 Continuing Calibration Verification (CCV)

Analyze a CCV each day prior to sample analysis and every 12 hours of analysis time. The 12-hour window is established from the injection time of the BFB.

Prepare the CCV standard(s) using the same source used to prepare the calibration standards at a concentration near the mid-level of your calibration range (Level 4). The recommended formulations for the CCV standards associated with each calibration scheme are provided in Appendix B. Analyze the CCV following the procedure specified in Section 10.5.

The data processing system acquires and calculates the RF and percent difference or drift for each target analyte and surrogate standard.

The following criteria must be met:

1) The percent difference / drift 80% of analytes must be ≤ 20%.

2) Minimum Response Factor for analytes listed in Attachment 1 must be met.

3) The internal standard retention time must be ± 10 seconds from the RT of the midpoint standard in the ICAL and the extracted ion current profile (EICP) area must be within -50% to +100% of the midpoint standard in the ICAL.

If the above criteria are not met, repeat the analysis of the CCV once. If the second CCV meets criteria, continue with the analytical sequence. If it fails, evaluate the data to determine if one of the following conditions is met:

- If the CCV criteria are exceeded high, indicating a high bias, and the associated samples have non-detects for those analytes, the analytical data may be considered usable. In the absence of instructions otherwise, proceed with analysis.

- If the CCV criteria are exceeded low, indicating a low bias, analytical results may be reported if those results exceed the project's regulatory decision level. In other words, if the analytical results are sufficiently high to counter the low bias, results may be reported. Consult with the project manager to determine if the exception is allowable for each project.

If these conditions are not met or it is suspected that the failure is caused by instrument failure, perform corrective action. After corrective action is performed, recalibrate the instrument

10.4 Sample Preparation

These sections describe the sample preparation procedures performed immediately prior to instrument analysis. The procedure for sample handling, preservation checks and screen analysis is described in a separate SOP.

See Attachment 2 for spike and surrogate amounts.

Note: The laboratory adds surrogate and spike standards directly to the 44 mL vial. The laboratory's LIMS system TALS bases all calculations on a vial volume of 40 mLs. To ensure the calculations work properly, the laboratory must convert the spike amount added to compensate for the difference in volume and enter the converted spike amount into the TALS system. See the documents in Attachment 2 for more information.

Water:

1) Warm the samples to ambient temperature and inspect each vial to ensure it is hermetically sealed and does not contain air bubbles. If an air bubble is present, do not use the vial.

2) Check the screen results. If the screen data indicates a dilution is needed, prepare the dilution as follows: Partially fill a 44 mL vial with VOA-free water. Inject the proper amount of sample to the vial and adjust the volume to 44 mL with reagent water. The sample aliquots used for dilution preparation should not be less than 1 mL. Repeat this procedure as needed to achieve additional dilutions (serial dilutions).

3) To prepare the MB and LCS fill a 44 mL VOA vial with VOA-free reagent water.

4) Using a gas tight syringe add an appropriate volume of internal standard and surrogate solution to each vial through the septum of the vial.

5) Using a gas tight syringe add the appropriate volume of spike solution to the LCS and each MS/MSD.

MeOH Extracts:

1) Warm the samples to ambient temperature.

2) Check the screen results. If the screen data indicates a dilution is needed, prepare the dilution as follows: Fill a 44 mL vial with VOA-free water. Inject the proper amount of sample to the vial and adjust the volume. Repeat this procedure as needed to achieve additional dilutions (serial dilutions).

3) For each sample and MS/MSD, fill a 44 mL VOA vial with VOA free reagent water and transfer 880 uL of the extract to the vial.

4) To prepare the MB and LCS fill a 44 mL vial with VOA-free water and add 880 uL of methanol to the vial.

6) Using a microliter syringe add an appropriate volume of internal standard and surrogate solution to each vial through the septum of the vial.

7) Using a microliter syringe add the appropriate volume of spike solution to the LCS and each MS/MSD.

Soil (Sodium Bisulfate Preserved)

1) Warm the samples to ambient temperature.

2) Check the screen results. If the screen data indicates a dilution is needed, prepare samples for medium level analysis by following the procedure for MeOH Extracts.

3) To prepare the sodium bisulfate preserved MB and LCS add 5 g of Ottawa sand to a pre-preserved sodium bisulfate 44 mL vial then immediately reseal the vial with the screw cap and septum seal.

4) Using a microliter syringe add an appropriate volume of internal standard and surrogate solution to each vial through the septum of the vial.

5) Using a microliter syringe add the appropriate volume of spike solution to the LCS and each MS/MSD.

Soil (Frozen Water Preserved)

1) Warm the samples to ambient temperature, and inspect each vial to ensure it is intact and free of cracks.

2) To prepare the frozen water MB and LCS use a prepared 44ml vial with VOA free water and stir bar.

3) Using a microliter syringe add an appropriate volume of internal standard and surrogate solution to each vial through the septum of the vial.

4) Using a microliter syringe add the appropriate volume of spike solution to the LCS and each MS/MSD.

10.5 Sample Analysis

Arrange the vials in a sequence that begins with the instrument performance check samples followed by QC and field samples.

An example analytical sequence that includes initial calibration (ICAL) is provided below.

Injection Number	Lab Description
1	BFB
2	ICAL Level 1
3	ICAL Level 2
4	ICAL Level 3
5	ICAL Level 4
6	ICAL Level 5
7	ICAL Level 6
8	Cleaning Blank
9	ICV
10	LCS

11	Cleaning blank
12	Method Blank
13-X	samples

NOTE: Analyze a MB and the LCS every 20 samples.

Enter the sample ID's into the data acquisition program in the order the samples were placed in the autosampler and initiate the analytical sequence.

After analysis, check and record the pH of the vial analyzed. Record the pH in the instrument run log and in the TALS worksheet.

11.0 Calculations / Data Reduction

11.1 Qualitative Identification

The data processing system tentatively identifies target analytes by comparing the retention time of the peaks to the window set around the continuing calibration standard, and searches in that area for the primary ion and up to two secondary ions characteristic of the target analyte.

All tentative identifications made by the computer are reviewed and either accepted or rejected by the primary analyst. The identification made by the system is accepted when the following criteria are met:

- Compare the background subtracted mass spectrum for each analyte to the reference spectrum in the user-created database. All ions present above 10% relative abundance in the mass spectrum of the standard should be present in the mass spectrum of the sample component and their relative abundances should agree within 20%.For example, if an ion has a relative abundance of 30% in the standard spectrum, its abundance in the sample spectrum should be in the range of 10-50%. Some ions, particularly the molecular ion, are of special importance if a tentative identification is to be made, and should be evaluated even if they are below 10% relative abundance.

- The GC retention time for the target analyte should be within 0.06 RRT units of the daily CCV standard.

- When GC peaks obviously represent more than one sample component (i.e., broadened peak with shoulder(s) or valley between two or more maxima), select appropriate analyte spectra and background spectra by examining plots of characteristic ions for tentatively identified components. When analytes co-elute (i.e., only one GC peak is apparent), identification criteria can be met but each analyte spectrum will contain extraneous ions contributed by the coeluting compound. Because purgeable organic compounds are relatively small molecules and produce comparatively simple mass spectra, this is not a significant problem for most method analytes.

- Structural isomers that produce very similar mass spectra can be explicitly identified only if they have sufficiently different GC retention times. Acceptable resolution is achieved if the height of the valley between two peaks is less than 25% of the average height of the two peaks. Otherwise, structural isomers are identified as isomeric pairs. Two of the three isomeric xylenes (m,p) are examples of structural isomers that are not resolved on the capillary column. These groups of isomers will be reported as isomeric pairs.

Identification requires expert judgment when sample components are not resolved chromatographically and produce mass spectra containing ions contributed by more than one analyte. When GC peaks obviously represent more than one sample component (i.e., broadened peak with shoulder(s) or valley between two or more maxima), appropriate analyte spectra and background spectra can be selected by examining plots of characteristic ions for tentatively identified components. When analytes coelute (i.e., only one GC peak is apparent), the identification criteria can be met but each analyte spectrum will contain extraneous ions contributed by the coeluting compound. If the data system does not properly integrate a peak, perform manual integration. All manual integration must be performed and documented in accordance with laboratory SOP BR-QA-006 *Manual Integration*.

11.1.1 Tentatively Identified Compounds (TICs)

Evalute for and report TICs when requested for the project.

To evaluate for TICs: Perform the library search, and visually compare the sample spectra with the nearest library search and assign a tentative identification If the match is 85% or greater use the name generated by the library search program otherwise call it an unknown. The library search should not include peaks that are < 10% of the nearest non contaminated internal standard, target analytes, or peaks that elute earlier than 30 seconds before the first target analyte.

Use the following criteria to qualitatively identify these compounds:

- Relative intensities of ions greater than 10% of the most abundant ion in the reference spectrum should be present in the sample spectrum.
- The relative intensities of the major ions should agree within ± 20%.
- Molecular ions present in the reference spectrum should be present in the sample spectrum.
- Ions present in the sample spectrum but not in the reference spectrum should be reviewed for possible background contamination or presence of coeluting compounds.

Once identified, the concentration of TICs are calculated using an RF of 1.00.

11.2 Quantitative Identification

After a compound has been identified, the data system quantifies the on-column concentration of the target compound based on the integrated abundance of the characteristic ion from the EICP. If there is matrix interference with the primary ion, a secondary ion may be used for quantification by calculating a mean RF factor for that ion and using that ion to quantify the analyte in the sample. When secondary ion calculations are required, include this information in the non-conformance report and project narrative.

Final results are calculated in TALS.

When quantification from a secondary ion is performed, document the situation with a NCM to notify the PM for discussion in the project narrative.

11.3 Calculations

See Appendix C.

11.4 Data Review

11.4.1 Primary Review (Performed by Primary Analyst)

Review the chromatography and quantitation in the data processing system to confirm quantitative and qualitative identification of each target analyte.

Upload the data files to TALS. Enter batch editor information and add the standards and reagents to the TALS batch. Review the results against acceptance criteria. If acceptance criteria are not met, make arrangements to perform corrective action.

Check the results of samples analyzed immediately after high concentration samples for signs of carry-over. Reanalyze the sample if carry over is suspected.

Dilute and reanalyze samples whose results exceed the calibration range. The diluted analysis should result in a determination within the upper half of the calibration curve.

Set results to primary, secondary, acceptable or rejected as appropriate.

Verify corrective action was taken for all results not within acceptance criteria. If corrective action is not taken or was unsuccessful, record all instances where criteria are not met with a nonconformance memo (NCM). Be sure to provide explanation of your decision making in the internal comment section of the NCM. The internal comment section should list the reason the NCM is suspected, which action (if any) was taken and why and the outcome of the action taken.

Review project documents such as the Project Plan (PP), Project Memo or any other document/process used to communicate project requirements to ensure those project requirements were met. If project requirements were not met, immediately notify the project manager (PM) to determine an appropriate course of action.

Set the batch to 1st level review.

11.4.2 Secondary Review (Performed by Peer Reviewer)

Review the project documents such as the Project Plan (PP), Project Memo or any other document/process used to communicate project requirements and verify project requirements were met. If project requirements were not met, immediately notify the project manager (PM) to determine an appropriate course of action.

Review the TALS batch editor to verify information is complete. Review the batch to verify that the procedures in this SOP were followed. If discrepancy is found, resolve the discrepancy and verify any modifications to the SOP are documented and approved.

Spot-check 15% of samples in the batch to verify quantitative and qualitative identification.

If manual integrations were performed:

- Review each manual integration to verify that the integration is consistent and compliant with the requirements specified in laboratory SOP BR-QA-005.
- Check to ensure an appropriate technical reason code is provided for each manual integration. Acceptable technical reason codes are provided in laboratory SOP BR-QA-005.
- Generate a “before” and “after” chromatogram for every manual integration performed on an instrument performance check standard (Tune, ICAL, ICV, CCV), QC sample (MB, LCS) and for any manual integration performed on any surrogate or internal standard in any field sample.
- Generate the Manual Integration Summary Report. Document your review of manual integrations on the summary report and obtain any review signatures of integrations performed during secondary review as required.

  If the reviewer disagrees with the integration performed by the primary analyst, the secondary data reviewer should not change the integration. Instead, he/she should consult with the primary analyst that performed the integration and both the reviewer and the primary analyst should agree the integration should be changed. If consensus between the primary analyst and the peer reviewer cannot be achieved; both should consult with the Technical Manager or department management for resolution. Any changes to the integration should be performed by the primary analyst. If it is necessary for the secondary reviewer to perform the manual integration because the primary analyst is out of the office; the integration made by the peer reviewer must be reviewed by another peer reviewer or by department management to verify the integration was performed and documented in compliance to SOP BR-QA-005. If the original analyst that performed the integration is out of the office, the data reviewer may consult with the Department Manager (DM), Department Supervisor (DS) or the Technical Manager (TM) to verify the change he/she thinks is needed is warranted and should be made.

Verify that the performance criteria for the QC items listed in Table 1 were met. If the results do not fall within the established limits verify that corrective actions were performed. If corrective action was not performed; verify the reason is provided and that the situation is properly documented with an NCM. Set samples to 2nd level review.

Run the QC checker and fix any problems found. Run and review the deliverable. Fix any problems found. When complete set the method chain to lab complete and forward any paperwork to report/project management.

11.5 Data Reporting

Data reporting and creation of the data deliverable is performed by TALS using the formatters set by the project manager during project initiation.

Electronic and hardcopy data are maintained as described in laboratory SOP BR-QA-014 Laboratory Records.

11.0 Method Performance

12.1 Detection Limit (DL), Limit of Detection (LOD) & Limit of Quantitation (LOQ)

Perform a DL study and verification at initial method set-up and when there is a significant change in instrumentation or procedure that affects the sensitivity of the method. See SOP BR-QA-005 for the procedure and requirements.

12.2 Demonstration of Capabilities (DOC)

Perform a method demonstration of capability at initial set-up and any time there is a significant change in instrumentation or procedure.

12.3 Training Requirements

Any employee that performs any portion of the procedure described in this SOP must have documentation in their employee training file that they have read this version of this SOP.

Instrument analysts, prior to independent analysis of client samples, must also have documentation of demonstration of initial proficiency (IDOC) and annual on-going proficiency (ODOC) in their employee training files.

12.0 Pollution Control

It is TestAmerica’s policy to evaluate each method and look for opportunities to minimize waste generated (i.e., examine recycling options, ordering chemicals based on quantity needed, preparation of reagents based on anticipated usage and reagent stability). Employees must abide by the policies in Section 13 of the Corporate Safety Manual for “Waste Management and Pollution Prevention.”

13.0 Waste Management

Waste management practices are conducted consistent with all applicable rules and regulations. Excess reagents, samples and method process wastes are disposed of in an accepted manner. Waste description rules and land disposal restrictions are followed. Waste disposal procedures are incorporated by reference to BR-EH-001.

The following waste streams are produced when this method is carried out.

- Aqueous Waste with pH between 4 and 9: Collect non-contaminated waste in a labeled 4 liter plastic satellite container. When satellite container is full, dispose the waste down the drain. Segregate any sample with a detect of target analyte for disposal by authorized personnel.

- Solvent Waste: Transfer to a labeled 4 liter glass satellite container kept in the fume hood. When the satellite container is full, notify the Hazardous Waste Coordinator who will arrange for transport of the waste to the hazardous waste room or to the solvent waste drum located in the extraction laboratory.

- Solid Waste in VOA Vial: Collect the vials in labeled 5 gallon plastic satellite containers located under each instrument bench. When the satellite container is full, notify the Hazardous Waste Coordinator who will arrange for transport of the waste to the hazardous waste room.

- Expired Standards: Place in a plastic bags and transport to the hazardous waste room for subsequent disposal by authorized personnel.

14.0 Method Modifications

Modification Number	Method Reference	Modification
1	Method 5030C Sec. 11.2.4.7.1	The laboratory prepares dilutions in 44 mL vials using gastight syringes or a 1-10 mL adjustable pipette.

15.0 References / Cross-References

- SW-846 Method 8260C, Revision 3, August 2006.
- SW-846 Method 5030C, Revision 3, Mary 2003.
- SW-846 Method 5035, Revision 0, December 1996.
- SW-846 Method 5035A, Draft Revision 1, July 2002.
- Laboratory SOP BR-QA-005
- Laboratory SOP BR-QA-011
- Laboratory SOP BR-LP-011
- Laboratory SOP BR-QA-014
- Laboratory Quality Assurance Manual (QAM)

16.0 Attachments

- Table 1: Primary Materials Used
- Table 2: Recommended Preservation Technique and Holding Tims
- Table 3: Tune Criteria
- Table 4: QC Summary and Recommended Corrective Action
- Appendix A: Terms and Definitions
- Appendix B: Standard Preparation Formulations
- Appendix C: Equations
- Attachment 1: Target List, RL, Limits and Supporting Information
- Attachment 2: Preparation Information Tables

17.0 Revision History

BR-MV-006, Revision 10.1

- Updated Approval signatures and dates

Throughout the changed references from 5030B to 5030C.

BR-MV-006, Revision 10

- This version of the SOP is a complete re-write from previous versions to update procedure to new version of the method 8260C.

BR-MV-006, Revision 9

- Updated Approval signatures
- Updated data review section to clarify responsibilities for each review function.
- Updated procedure for initial calibration to clarify criteria, when an exception may be allowed and requirements for the qualification of data.
- Updated control limits and replaced several tables in the prior version with tables now in Attachment 1 and Attachment 2.

BR-MV-006, Revision 8

- Updated Approval Signatures and Copyright
- Updated data review section to conform to laboratory SOP for data review and added LIMS procedures.
- Changed terms in method performance section from MDL to LOD and LOQ.
- Removed all references to DoD protocol.
- Removed Appendix E for marginal exceedance evaluation.

BR-MV-006, Revision 7

- This version of the SOP is a complete re-write from previous versions. All sections were significantly revised to be consistent with current practice and to incorporate purge and trap and autosampler conditions.

Table 1: Primary Materials Used

Material[1]	Hazards	Exposure Limit[2]	Signs and symptoms of exposure
Methanol	Flammable Poison Irritant	200 ppm-TWA	A slight irritant to the mucous membranes. Toxic effects exerted upon nervous system, particularly the optic nerve. Symptoms of overexposure may include headache, drowsiness and dizziness. Methyl alcohol is a defatting agent and may cause skin to become dry and cracked. Skin absorption can occur; symptoms may parallel inhalation exposure. Irritant to the eyes.

[1] *Always add acid to water to prevent violent reactions.*
[2] *Exposure limit refers to the OSHA regulatory exposure limit.*

Table 2: Recommended Sample Preservation Technique and Holding Times

Matrix	Preservation[1]	Holding Time[2]	Reference
Water	Collect in HCl pre-preserved container and cool to 4± 2ºC until time of analysis.	If pH on laboratory receipt is <2, 14 days. If pH > 2, 7 days.	SW-846 5030C
Water	Cool to 4± 2ºC until time of analysis.	7 days	SW-846 5035A
Soil	Sample is cooled upon collection to 4± 2ºC for 48 hours or less. On laboratory receipt, the sample is extruded into a vial containing reagent water and sodium bisulfate and cooled to 4± 2ºC until analysis.	If samples are preserved within 48 hours, 14 days.	SW-846 5035
Soil	Sample is extruded into empty sealed vial and cooled to 4± 2ºC for 48 hours or less. On laboratory receipt, the sample is frozen on receipt to < -7ºC.	If samples are preserved within 48 hours, 14 days.	SW-846 5035A
Soil	Sample is extruded into empty sealed vial and cooled to 4± 2ºC for 48 hours or less. On laboratory receipt, the sample is preserved with methanol and cooled to 4± 2ºC until analysis.	If samples are preserved within 48 hours, 14 days.	SW-846 5035A
Soil	Sample is extruded into vial containing reagent water and cooled to 4± 2ºC for 48 hours or less. On laboratory receipt, the sample is frozen on receipt to < -7ºC.	If samples are preserved within 48 hours, 14 days.	SW-846 5035A

[1] Reactive compounds such as 2-chloroethylvinyl ether readily break down under acidic conditions and this compound will not be recovered during analysis in samples that are preserved.

[2] It is accepted industry practice to apply a 7 day hold-time for water samples that are insufficiently field-preserved to a pH <2 even though the SW-846 methods do not specifically include this allowance. Clarification from the EHSG MICE line indicates a 7 day holding time is considered acceptable for chemically unpreserved aqueous samples unless the aromatic constituents such as benzene, toluene, ethylbenzene, and xylenes (BTEX) are among the analytes of interest in which case acidification is required for biologically active samples because it has been demonstrated that losses can occur within four hours of sample collection.

Based on this clarification from the EHGS MICE line, when the laboratory receives samples that are not sufficiently preserved to a pH <2, the laboratory will check each subsequent vial received. If one of the vials is adequately preserved, the laboratory will apply a 14 day hold time and use that vial for analysis. If none of the vials are adequately preserved, the analyst will initiate a nonconformance report (NCR) and immediately notify the PM who will contact the client for further instruction. While awaiting client instruction, the laboratory will expedite analysis for to try to meet a 7 day holding time. The PM will include any client instruction to proceed with analysis in the project narrative.

Table 3: BFB Key Ions and Ion Abundance Criteria

Mass	Ion Abundance Criteria
50	15.0-40.0 percent of mass 95
75	30.0-60.0 percent of mass 95
95	Base peak, 100 percent relative abundance
96	5.0-9.0 percent of mass 95
173	Less than 2.0 percent of mass 174
174	50.0 percent of mass 95
175	5.0-9.0 percent of mass 174
176	95.0-101.0 percent of mass 174
177	5.0-9.0 percent of mass 176

Table 4: QC Summary, Frequency, Acceptance Criteria and Recommended Corrective Action

QC Item	Minimum Frequency	Acceptance Criteria	Recommended Corrective Action[1]
Tune Standard	Prior to calibration and every 12 hours during sample analysis	See Table 4	Reanalyze.
5- Point ICAL	Before sample analysis, when CCVs indicate calibration is no longer valid; after major instrument maintenance	• %RSD for 90% of analytes: ≤ 20% • Correlation Coefficient : r ≥ 0.99 • See Attachment 1 for Min RF	Correct problem and repeat initial calibration for failure to meet %RSD for more then 90% of the compounds. If Min RF are not met contact project manager to determine if failure impacts data quality objectives (DQOs).
ICV	After each initial calibration	%R (70-130)	Correct problem and verify second source standard. If that fails, repeat initial calibration.
CCV	Beginning of each 12-hour window, as established by a compliant BFB.	• %D for 80% of analytes: ≤ 20% • See Attachment 1 for Min RF	Re-analyze once, if still outside criteria perform corrective action, sequence can be re-started if two successive CCVs at different concentrations pass, otherwise repeat ICAL and all associated samples since last successful CCV, unless CCV is high and samples are non-detects. If Min are not met contact project manager to determine if failure impacts data quality objectives.
MB	One per batch of 20 or fewer samples	< RL	Examine project DQO's and take appropriate corrective action, which may include re-analysis of MB and samples (if samples have been run), and/or non-conformance report (NCR). Corrective action must be documented on NCR. If there are no detects in samples, or if all detects are > 10 X MB level, reanalysis may not be required.
LCS	One per batch of 20 or fewer samples	See Attachment 1	Evaluate for marginal exceedance; examine project DQO's and take appropriate corrective action, which may include re-analysis of LCS and samples (if samples have been run), and/or non-conformance report (NCR). Corrective action must be documented on NCR. Flag all reported values outside of control limits.
MS/MSD SD	MS/MSD: Per extraction batch, DoD: project specific per extraction batch SD: Per client request	See Attachment 1	Evaluate data and determine if a matrix effect or analytical error is indicated. If analytical error, re-analyze. Flag all reported values outside of control limits.
Surrogate Standard	All field and QC samples	See Attachment 1	Evaluate data and determine if a matrix effect or analytical error is indicated. If analytical error, re-analyze. If matrix effect, review project DQOs to determine if a matrix effect must be confirmed by re-analysis. Flag all reported values outside of control limits.
Internal Standard	All field and QC samples	Area between 50-100% of area of daily calibration internal standard area	Same as above.

[1] *The recommended corrective action may include some or all of the items listed in this column. The corrective action taken may be dependent on project data quality objectives and/or analyst judgment but must be sufficient to ensure that data quality is known and documented. If corrective action is not taken or is not successful, data must be flagged with appropriate qualifiers.*

Appendix A: Terms and Definitions

Acceptance Criteria: specified limits placed on characteristics of an item, process or service defined in requirement documents.

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.

Analyte: The specific chemicals or components for which a sample is analyzed. (EPA Risk Assessment Guide for Superfund, OSHA Glossary).

Batch: environmental samples that are prepared and/or analyzed together with the same process, using the same lot(s) of reagents. A preparation/digestion batch is composed of one to 20 environmental samples of similar matrix, meeting the above criteria. An analytical batch is composed of prepared environmental samples (extracts, digestates and concentrates), which are analyzed together as a group.

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 the standards.

Calibration Curve: the graphical relationship between the known values or a series of calibration standards and their instrument response.

Calibration Standard: A substance or reference used to calibrate an instrument.

Continuing Calibration Verification (CCV): a single or multi-parameter calibration standard used to verify the stability of the method over time. Usually from the same source as the calibration curve.

Corrective Action: the action taken to eliminate the cause of an existing nonconformity, defect or other undesirable occurrence in order to prevent recurrence.

Data Qualifier: a letter designation or symbol appended to an analytical result used to convey information to the data user. (Laboratory)

Demonstration of Capability (DOC): procedure to establish the ability to generate acceptable accuracy and precision.

Holding Time: the maximum time that a sample may be held before preparation and/or analysis as promulgated by regulation or as specified in a test method.

Initial Calibration: Analysis of analytical standards for a series of different specified concentrations used to define the quantitative response, linearity and dynamic range of the instrument to target analytes.

Intermediate Standard: a solution made from one or more stock standards at a concentration between the stock and working standard. Intermediate standards may be certified stock standard solutions purchased from a vendor and are also known as secondary standards.

Laboratory Control Sample (LCS): a blank matrix spiked with a known amount of analyte(s) processed simultaneously with and under the same conditions as samples through all steps of the procedure.

Matrix Spike (MS): a field sample to which a known amount of target analyte(s) is added.

Matrix Spike Duplicate (MSD): a second replicate matrix spike

Method Blank (MB): a blank matrix processed simultaneously with and under the same conditions as samples through all steps of the procedure. Also known as the preparation blank (PB).

Method Detection Limit (MDL): 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 measurement system. The MDL is a statistical estimation at a specified confidence interval of the concentration at which relative uncertainty is ±100%. The MDL represents a <u>range</u> where qualitative detection occurs. Quantitative results are not produced in this range.

Non-conformance: an indication, judgment, or state of not having met the requirements of the relevant specification, contract or regulation.

Precision: the degree to which a set of observations or measurements of the same property, obtained under similar conditions, conform to themselves.

Preservation: refrigeration and/or reagents added at the time of sample collection to maintain the chemical, physical, and/or biological integrity of the sample.

Quality Control Sample (QC): a sample used to assess the performance of all or a portion of the measurement system.

Reporting Limit (RL): the level to which data is reported for a specific test method and/or sample.

Stock Standard: a solution made with one or more neat standards usually with a high concentration. Also known as a primary standard. Stock standards may be certified solutions purchased from a vendor.

Surrogate: a substance with properties that mimic the analyte of interest but that are unlikely to be found in environmental samples.

Appendix B: Standard Preparation Tables

The standard formulations contained in this Appendix are recommended and are subject to change. If the concentration of the stock standard is different than those noted in this table, adjust the standard preparation formulation accordingly.

Prepare the standards using P&T grade methanol and Class A volumetric glassware. Store prepared standards at -10 to -20°C in amber glass mini-inert vials, except for the routine level water and medium level surrogate and internal standard solutions, which may be stored in volumetric flasks at 2-6°C. Assign the expiration date from the date prepared unless the expiration date of the parent components expires sooner in which case use the earliest expiration date.

Tune Standard (BFB) (25 ug/mL)

Parent Standard	Vendor	Stock Standard Concentration (ug/mL)	Volume Added (uL)	Final Volume (uL)	Final Concentration (ug/mL)
Bromofluorobenzene	Restek 30003	5000	125	25000	25

Expiration Date: 6 Month

Internal Standard (50 ug/mL)

Parent Standard	Vendor	Stock Standard Concentration (ug/mL)	Volume Added (uL)	Final Volume (uL)	Final Concentration (ug/mL)
Chlorobenzene-d5	Restek 50684	1000	1250	25000	50
1,4-Dichlorobenzene-d4					
Fluororbenzene					

Expiration Date: 1 Month

Surrogate Standard (50 ug/mL)

Parent Standard	Vendor	Stock Standard Concentration (ug/mL)	Volume Added (uL)	Final Volume (uL)	Final Concentration (ug/mL)
Bromofluorobenzene	Restek 53837	2000	625	25000	50
1,2-Dichlorobenzene-d_4					
1,2-Dichloroethane-d_4					
Toluene-d_8					

Expiration Date: 1 Month

Intermediate Calibration TBA (2500 ug/mL)

Parent Standard	Vendor	Stock Standard Concentration (ug/mL)	Volume Added (uL)	Final Volume (uL)	Final Concentration (ug/mL)
tert-Butyl Alcohol	Restek 30470	50,000	100	2000	2500

Expiration Date: 2 months

ICV/LCS TBA (2500 ug/mL)

Parent Standard	Vendor	Stock Standard Concentration (ug/mL)	Volume Added (uL)	Final Volume (uL)	Final Concentration (ug/mL)
tert-Butyl alcohol	Ultra Scientific CUS-10128	50,000	100	2000	2500

Expiration Date: 2 month

SOIL Intermediate Calibration Mix A – Gases (200 ug/mL)

Parent Standard	Vendor	Stock Standard Concentration (ug/mL)	Volume Added (uL)	Final Volume (uL)	Final Concentration (ug/mL)
Bromomethane	Restek 30042	2000	125	1250	200
Chloroethane		2000			200
Chloromethane		2000			200
Dichlorodifluoromethane		2000			200
Trichlorofluoromethane		2000			200
Vinyl Chloride		2000			200
2, Chloroethyl vinyl ether	Restek 30265	2000	125	1250	200

Expiration Date: 1 Week

SOIL Intermediate Calibration Mix B – Cal Mix (Mixed Concentration)

Parent Standard	Vendor	Stock Standard Concentration (ug/mL)	Volume Added (uL)	Final Volume (uL)	Final Concentration (ug/mL)
Bromofluorobenzene (SSTD)	Restek 53837	2000	400	4000	200
1,2-Dichlorobenzene-d_4 (SSTD)					200
1,2-Dichloroethane-d_4 (SSTD)					200
Toluene-d_8 (SSTD)					200
Vinyl acetate	Restek 30216	2000	400	4000	200
Methyl methacrylate	Restek 559530	2000	400	4000	200
Allyl chloride		2000			200
Acrylonitrile		2000			200
Ethyl methacrylate		2000			200
Benzene	Restek 30431	2000	400	4000	200
Bromobenzene		2000			200
Bromochloromethane		2000			200
Bromodichloromethane		2000			200
Bromoform		2000			200
n-butylbenzene		2000			200
sec-butylbenzene		2000			200
tert-butylbenzene		2000			200
Carbon tetrachloride		2000			200
Chlorobenzene		2000			200
Chloroform		2000			200
2-Chlorotoluene		2000			200
4-Chlorotoluene		2000			200
Dibromochloromethane		2000			200
1,2-Dibromo-3-chloropropane		2000			200
1,2-dibromoethane		2000			200
Dibromomethane		2000			200
1,2-dichlorobenzene		2000			200
1,3-dichlorobenzene		2000			200
1,4-dichlorobenzene		2000			200
1,1-dichloroethane		2000			200
1,2-dichloroethane		2000			200
1,1-dichloroethene		2000			200
cis-1,2-Dichloroethene		2000			200
trans-1,2-Dichloroethene		2000			200
1,2-Dichloropropane		2000			200
1,3-Dichloropropane		2000			200
2,2-Dichloropropane		2000			200
1,1-Dichloropropene		2000			200

cis-1,3-Dichloropropene		2000			200
trans-1,3-Dichloropropene					
Ethylbenzene		2000			200
Hexachlorobutadiene		2000			200
Isopropylbenzene		2000			200
4-Isopropyltoluene		2000			200
Methylene chloride		2000			200
Naphthalene		2000			200
n-Propylbenzene		2000			200
Styrene		2000			200
1,1,1,2-Tetrachloroethane		2000			200
1,1,2,2-Tetrachloroethane		2000			200
Tetrachloroethene		2000			200
Toluene		2000			200
1,2,3-Trichlorobenzene		2000			200
1,2,4-Trichlorobenzene		2000			200
1,1,1-Trichloroethane		2000			200
1,1,2-Trichloroethane		2000			200
Trichloroethene		2000			200
1,2,3-Trichloropropane		2000			200
1,2,4-Trimethylbenzene		2000			200
1,3,5-Trimethylbenzene		2000			200
m-Xylene		2000			200
o-Xylene		2000			200
p-Xylene		2000			200
1,4-Dioxane	Restek 56531	100,000	400	4000	10000
Isobutyl alcohol		100,000			10000
Tetrahydrofuran		18000			1800
Propionitrile		8000			800
trans-1,4-Dichloro-2-butene		2000			200
1,1,2-Trichlorotrifluoroethane (Freon TF)		2000			200
Chloroprene (2-Chloro-1,3-butadiene)		2000			200
Carbon disulfide		2000			200
Methacrylonitrile		2000			200
Methyl-tert-butyl ether		2000			200
Iodomethane (Methyl iodide)		2000			200
Methyl cyclohexane	Restek 563602	5000	160	4000	200
Cyclohexane		5000			200
Methyl acetate		5000			200

Expiration Date: 1 Month

SOIL Intermediate Calibration Mix C - Addeds (200 ug/mL)

Parent Standard	Vendor	Stock Standard Concentration (ug/mL)	Volume Added (uL)	Final Volume (uL)	Final Concentration (ug/mL)
2-Chloroethylvinylether	Restek 30265	2000	400	4000	200
Acrolein	Restek 30645	5000	160	4000	200
Acetone	Restek 30300	2000	400	4000	200
4-Methyl-2-pentanone					200
2-Butanone					200
Tetrahydrofuran					200
2-hexanone					200

Expiration Date: 1 Month

SOIL Intermediate ICV/LCS Mix A - Gases (200ug/mL)

Parent Standard	Vendor	Stock Standard Concentration (ug/mL)	Volume Added (uL)	Final Volume (uL)	Final Concentration (ug/mL)
Bromomethane	Accustandard M-502C-1	2000	31.2	1250	200
Chloroethane		2000			200
Chloromethane		2000			200
Dichlorodifluoromethane		2000			200
Trichlorofluoromethane		2000			200
Vinyl chloride		2000			200
2-Chloroethylvinylether	Ultra Scientific EPA-1016	5000	50	1250	200

Expiration Date: 1 week

SOIL Intermediate ICV/LCS Mix B – LCS Mix (Mixed Concentration)

Parent Standard	Vendor	Stock Standard Concentration (ug/mL)	Volume Added (uL)	Final Volume (uL)	Final Concentration (ug/mL)
Vinyl acetate	Ultra Scientific CUS 6019	2000	400	4000	200
Allyl chloride	Ultra Scientific CUS 8562	2000	400	4000	200
Methyl methacrylate					
Ethyl methacrylate					
Acrylonitrile	Ultra Scientific EPA 1002	5000	160	4000	200
Benzene	Ultra Scientific DWM-589N	2000	400	4000	200
Bromobenzene					
Bromochloromethane					
Bromodichloromethane					
Bromoform					
n-butylbenzene					
sec-butylbenzene					
tert-butylbenzene					
Carbon tetrachloride					
Chlorobenzene					
Chloroform					
2-Chlorotoluene					
4-Chlorotoluene					
Dibromochloromethane					
1,2-Dibromo-3-chloropropane					
1,2-Dibromoethane					
Dibromomethane					
1,2-Dichlorobenzene					
1,3-Dichlorobenzene					
1,4-Dichlorobenzene					
1,1-Dichloroethane					
1,2-Dichloroethane					
1,1-Dichloroethene					
cis-1,2-Dichloroethene					
trans-1,2-Dichloroethene					
1,2-Dichloropropane					
1,3-Dichloropropane					
2,2-Dichloropropane					
1,1-Dichloropropene					

cis-1,3-Dichloropropene					
trans-1,3-Dichloropropene					
Ethylbenzene					
Hexachlorobutadiene					
Isopropylbenzene					
4-Isopropyltoluene					
Methylene chloride					
Naphthalene					
n-Propylbenzene					
Styrene					
1,1,1,2-Tetrachloroethane					
1,1,2,2-Tetrachloroethane					
Tetrachloroethene					
Toluene					
1,2,3-Trichlorobenzene					
1,2,4-Trichlorobenzene					
1,1,1,-Trichloroethane					
1,1,2,-Trichloroethane					
Trichloroethene					
1,2,3-Trichloropropane					
1,2,4-Trimethylbenzene					
1,3,5-Trimethylbenzene					
o-xylene					
m-xylene					
p-xylene					
1,1,2-Trichlorotrifluoroethane (Freon TF)	Ultra Scientific CUS-9442	2000	400	4000	200
Iodomethane (Methyl iodide)		2000			200
Carbon disulfide		2000			200
MTBE		2000			200
Propionitrile		8000			800
Methacrylonitrile		2000			200
Isobutyl alcohol		100,000			10,000
Tetrahydrofuran		18,000			1800
1,4-dioxane		100,000			10,000
trans-1,4-Dichloro-2-butene		2000			200
Chloroprene(2-chloro-1,3-butadiene)		2000			200
Methyl cyclohexane	Ultra Scientific CUS-10269	5000	160	4000	200
Cyclohexane		5000			200
Methyl acetate		5000			200

Expiration Date: 1 Month

SOIL Intermediate ICV/LCS Mix C - Addeds (200ug/mL)

Parent Standard	Vendor	Stock Standard Concentration (ug/mL)	Volume Added (uL)	Final Volume (uL)	Final Concentration (ug/mL)
Acrolein	Ultra Scientific CUS 9748	2000	400	4000	200
Acetone	Accustandard S-4352-R1	2000	400	4000	200
2-Butanone					200
4-Methyl-2-pentanone					200
Tetrahydrofuran					200
2-Hexanone					200

Expiration Date: 1 Month

WATER Intermediate Calibration Mix A – Gases (50 ug/mL)

Parent Standard	Vendor	Stock Standard Concentration (ug/mL)	Volume Added (uL)	Final Volume (uL)	Final Concentration (ug/mL)
Bromomethane	Restek 30042	2000	31.2	1250	50
Chloroethane		2000			50
Chloromethane		2000			50
Dichlorodifluoromethane		2000			50
Trichlorofluoromethane		2000			50
Vinyl Chloride		2000			50
2-Chloroethylvinylether	Restek 30265	2000	31.2	1250	50

Expiration Date: 1 Week

WATER Intermediate Calibration Mix B – Cal Mix (Mixed Concentration (ug/mL)

Parent Standard	Vendor	Stock Standard Concentration (ug/mL)	Volume Added (uL)	Final Volume (uL)	Final Concentration (ug/mL)
Bromofluorobenzene (SSTD)	Restek 53837	2000	110	4400	50
1,2-Dichlorobenzene-d_4 (SSTD)					50
1,2-Dichloroethane-d_4 (SSTD)					50
Toluene-d_8 (SSTD)					50
Vinyl Acetate	Restek 30216	2000	110	4400	50
Methyl methacrylate	Restek 559530	2000	110	4400	50
Allyl chloride		2000			50
Acrylonitrile		2000			50
Ethyl methacrylate		2000			50
Benzene	Restek 30431	2000	110	4400	50
Bromobenzene		2000			50
Bromochloromethane		2000			50
Bromodichloromethane		2000			50
Bromoform		2000			50
n-Butylbenzene		2000			50
sec-Butylbenzene		2000			50
tert-Butylbenzene		2000			50
Carbon tetrachloride		2000			50
Chlorobenzene		2000			50
Chloroform		2000			50
2-Chlorotoluene		2000			50
4-Chlorotoluene		2000			50
Dibromochloromethane		2000			50
1,2-Dibromo-3-chloropropane		2000			50
1,2-Dibromoethane		2000			50
Dibromomethane		2000			50
1,2-Dichlorobenzene		2000			50
1,3-Dichlorobenzene		2000			50
1,4-Dichlorobenzene		2000			50
1,1-Dichloroethane		2000			50
1,2-Dichloroethane		2000			50
1,1-Dichloroethene		2000			50
cis-1,2-Dichloroethene		2000			50
trans-1,2-Dichloroethene		2000			50
1,2-Dichloropropane		2000			50
1,3-Dichloropropane		2000			50
2,2-Dichloropropane		2000			50
1,1-Dichloropropene		2000			50

cis-1,3-Dichloropropene		2000			50
trans-1,3-Dichloropropene		2000			50
Ethylbenzene		2000			50
Hexachlorobutadiene		2000			50
Isopropylbenzene		2000			50
4-Isopropyltoluene		2000			50
Methylene chloride		2000			50
Naphthalene		2000			50
n-Propylbenzene		2000			50
Styrene		2000			50
1,1,1,2-Tetrachloroethane		2000			50
1,1,2,2-Tetrachloroethane		2000			50
Tetrachloroethene		2000			50
Toluene		2000			50
1,2,3-Trichlorobenzene		2000			50
1,2,4-Trichlorobenzene		2000			50
1,1,1-Trichloroethane		2000			50
1,1,2-Trichloroethane		2000			50
Trichloroethene		2000			50
1,2,3-Trichloropropane		2000			50
1,2,4-Trimethylbenzene		2000			50
1,3,5-Trimethylbenzene		2000			50
m-Xylene		2000			50
o-Xylene		2000			50
p-Xylene		2000			50
1,4-Dioxane	Restek 56531	100,000	110	4400	2500
Isobutyl alcohol		100,000			2500
Tetrahydrofuran		18,000			450
Propionitrile		8000			200
trans-1,4-Dichloro-2-butene		2000			50
1,1,2-Trichlorotrifluoroethane (Freon TF)		2000			50
Chloroprene (2-Chloro-1,3-butadiene)		2000			50
Carbon disulfide		2000			50
Methacrylonitrile		2000			50
Methyl-tert-butyl ether		2000			50
Iodomethane (Methyl Iodide)		2000			50
Cyclohexane	Restek 563602	5000	44	4400	50
Methylcyclohexane		5000			50
Methyl acetate		5000			50

Expiration Date: 1 Month

WATER Intermediate Calibration MixC - Addeds (250 ug/mL)

Parent Standard	Vendor	Stock Standard Concentration (ug/mL)	Volume Added (uL)	Final Volume (uL)	Final Concentration (ug/mL)
Acrolein	Restek 30645	5000	220	4400	250
Acetone	Restek 30300	2000	550	4400	250
4-Methyl-2-pentanone		2000			250
2-hexanone		2000			250
Tetrahydrofuran		2000			250
2-butanone		2000			250

Expiration Date: 1 Month

Water Intermediate ICV/LCS Mix B – LCS Mix (Mixed Concentration ug/mL)

Parent Standard	Vendor	Stock Standard Concentration (ug/mL)	Volume Added (uL)	Final Volume (uL)	Final Concentration (ug/mL)
Vinyl acetate	Ultra Scientific CUS-6019	2000	110	4400	50
Acrylonitrile	Ultra Scientific EPA-1002	5000	44	4400	50
Methyl methacrylate	Ultra Scientific CUS-8562	2000	110	4400	50
Allyl chloride		2000			50
Ethyl methacrylate		2000			50
Benzene	Ultra Scientific DWM-589N	2000	110	4400	50
Bromobenzene		2000			50
Bromochloromethane		2000			50
Bromodichloromethane		2000			50
Bromoform		2000			50
n-Butylbenzene		2000			50
sec-Butylbenzene		2000			50
tert-Butylbenzene		2000			50
Carbon tetrachloride		2000			50
Chlorobenzene		2000			50
Chloroform		2000			50
2-Chlorotoluene		2000			50
4-Chlorotoluene		2000			50
Dibromochloromethane		2000			50
1,2-Dibromo-3-chloropropane		2000			50
1,2-Dibromoethane		2000			50
Dibromomethane		2000			50
1,2-Dichlorobenzene		2000			50
1,3-Dichlorobenzene		2000			50
1,4-Dichlorobenzene		2000			50
1,1-Dichloroethane		2000			50
1,2-Dichloroethane		2000			50
1,1-Dichloroethene		2000			50
cis-1,2-Dichloroethene		2000			50
trans-1,2-Dichloroethene		2000			50
1,2-Dichloropropane		2000			50
1,3-Dichloropropane		2000			50
2,2-Dichloropropane		2000			50
1,1-Dichloropropene		2000			50
cis-1,3-Dichloropropene		2000			50
trans-1,3-Dichloropropene		2000			50
Ethylbenzene		2000			50
Hexachlorobutadiene		2000			50
Isopropylbenzene		2000			50
4-Isopropyltoluene		2000			50
Methylene chloride		2000			50
Naphthalene		2000			50
n-Propylbenzene		2000			50
Styrene		2000			50
1,1,1,2-Tetrachloroethane		2000			50
1,1,2,2-Tetrachloroethane		2000			50
Tetrachloroethene		2000			50
Toluene		2000			50
1,2,3-Trichlorobenzene		2000			50
1,2,4-Trichlorobenzene		2000			50
1,1,1-Trichloroethane		2000			50
1,1,2-Trichloroethane		2000			50

Trichloroethene		2000			50
1,2,3-Trichloropropane		2000			50
1,2,4-Trimethylbenzene		2000			50
1,3,5-Trimethylbenzene		2000			50
m-Xylene		2000			50
o-Xylene		2000			50
p-Xylene		2000			50
1,4-Dioxane	Ultra Scientific CUS-9442	100,000	110	4400	2500
Isobutyl alcohol		100,000			2500
Tetrahydrofuran		18,000			450
Propionitrile		8000			200
trans-1,4-Dichloro-2-butene		2000			50
1,1,2-Trichlorotrifluoroethane (Freon TF)		2000			50
Chloroprene (2-Chloro-1,3-butadiene)		2000			50
Carbon disulfide		2000			50
Methacrylonitrile		2000			50
Methyl-tert-butyl ether		2000			50
Iodomethane (Methyl iodide)		2000			50
Cyclohexane	Restek 563602	5000	44	4400	50
Methylcyclohexane	Restek 563602	5000	44	4400	50
Methyl acetate	Restek 563602	5000	44	4400	50

Expiration Date: 1 Month

Water Intermediate ICV/LCS Mix C - Addeds (Mixed ug/mL)

Parent Standard	Vendor	Stock Standard Concentration (ug/mL)	Volume Added (uL)	Final Volume (uL)	Final Concentration (ug/mL)
Acrolein	Ultra Scientific CUS-9748	10,000	110	4400	250
Acetone	Accustandard S-4352-R1	2000	550	4400	250
4-Methyl-2-pentanone (MIBK)		2000			250
2-hexanone		2000			250
Tetrahydrofuran		2000			250
2-butanone (MEK)		2000			250

Expiration Date: 1 Month

Water Intermediate ICV/LCS Mix – A Gases (50 ug/mL)

Parent Standard	Vendor	Stock Standard Concentration (ug/mL)	Volume Added (uL)	Final Volume (uL)	Final Concentration (ug/mL)
Bromomethane	Accustandard M-502C-01	2000	31.2	1250	50
Chloroethane		2000			50
Chloromethane		2000			50
Dichlorodifluoromethane		2000			50
Trichlorofluoromethane		2000			50
Vinyl Chloride		2000			50
2-Chloroethylvinylether	Ultra Scientific CUS-1016	5000	12.5	1250	50

Expiration Date: 1 Week

Appendix C: Equations

Response Factor (RFx) = $$\frac{\text{Area}_x \times \text{Concentration}_{is}}{\text{Area}_{is} \times \text{Concentration}_x}$$

Where: x=compound, is = Internal Standard

Relative Retention Time (RRT) = $$\frac{\text{Retention Time}_x}{\text{Retention Time}_{is}}$$

Where: x=compound, is = Internal Standard

Mean Response Factor ($\overline{RF}$) = $$\frac{\sum_{i=1}^{n} RF_i}{n}$$

where: n = number of calibration levels

Standard Deviation of the Response Factor (SD) = $$\sqrt{\frac{\sum_{i=1}^{n}\left(RF_i - \overline{RF}\right)2}{n-1}}$$

where: n = number of calibration levels

Percent Relative Standard Deviation (RSD) of the Response = $$\frac{SD}{\overline{\overline{RF}}} \times 100\%$$

Percent Difference (%D) = $$\frac{RF_v - \overline{RF}}{\overline{\overline{RF}}} \times 100\%$$

where: RF_v = Response Factor from the Continuing Calibration Verification (CCV)

Percent Drift = $$\frac{\text{Calculated Concentration} - \text{Theoretical Concentration}}{\text{Theoretical Concentration}} \times 100\%$$

Percent Recovery (%R) = $\frac{C_s}{C_n} \times 100\%$

where: C_s = Concentration of the Spiked Field or QC Sample
C_n = Nominal Concentration of Spike Added

Percent Recovery (%R) for MS/MSD = $\frac{C_s - C_u}{C_n} \times 100\%$

where: C_s = Concentration of the Spiked Sample
C_u = Concentration of the Unspiked Sample
C_n = Nominal Concentration of Spike Added

Relative Percent Difference (%RPD) = $\frac{C_1 - C_2}{\left(\frac{C_1 + C_2}{2}\right)} \times 100\%$

where: C_1 = Measured Concentration of First Sample
C_2 = Measured Concentration of Second Sample

Sample Concentration

Water

$$C_x = \frac{A_x \times C_{is}}{A_{is} \times \text{Mean RF}} \times DF$$

Solids

$$C_x = \frac{A_x \times C_{is}}{A_{is} \times \text{Mean RF} \times \text{Percent Solids}} \times DF$$

Where

C_x = Concentration of compound (µg/L)
A_{is} = Area of quantification ion for associated internal standard.
A_x = Area of quantification ion for compound.
C_{is} = Concentration of associated internal standard (µg/L).
DF = Dilution Factor.
Mean RF = Mean Response Factor from initial calibration, or 1 for a tentatively identified compound

ATTACHMENT 1: SW-846 8260C Method Information

The tables associated to Attachment 1 summarize the laboratory's established RL for each matrix along with the in-house control limits for accuracy and precision, internal standard associations, characteristic ions used for quantitation and minimum response factor criteria for each analyte.

The RL's provided in these tables are those that can be achieved in a blank water or soil matrix using the routine extraction volume / mass of sample specified in the laboratory SOP for these matrices. These RLs are always adjusted for field samples based on actual sample amount used, final extract volume, percent moisture (solids) and dilutions.

The information provided in these tables is entered in the laboratory's management information system (LIMS) called TALS and is kept current by the local TALS system administrator. The values in TALS are the values used by the laboratory's data processing systems to evaluate and report data. The information presented in these tables is pulled from TALS and current as of the effective date of this SOP but is subject to change. Updates to these tables are made with each SOP revision. For the most current information, refer to the method, equipment and ICAL limit groups maintained in the TALS database.

Attachment 1: SW846 8260C Method Information (BR-MV-006)

Type	Analytes	CAS#	RL			Control Limits (%R)						Precision	Internal	Characterisitc Ion			Minimum RF
			Water	Soil	MeOH	Water		Low Soil		MeoH^1		RPD	Standard				
			(ug/L)	(ug/Kg)	(ug/Kg)	Lower	Upper	Lower	Upper	Lower	Upper	≤	Association	Primary	Secondary	Tertiary	
Analyte	1,1,1,2-Tetrachloroethane	630-20-6	1.0	5.0	100	80	120	75	120	80	120	30	ISTD2	131	133	117	
Analyte	1,1,1-Trichloroethane	71-55-6	1.0	5.0	100	75	120	70	120	75	120	30	ISTD1	97	99	61	0.100
Analyte	1,1,2,2-Tetrachloroethane	79-34-5	1.0	5.0	100	80	125	75	120	80	125	30	ISTD3	83	85	131	0.300
Analyte	1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	1.0	5.0	100	70	120	65	120	70	120	30	ISTD1	151	101	153	0.100
Analyte	1,1,2-Trichloroethane	79-00-5	1.0	5.0	100	80	125	75	120	80	125	30	ISTD2	83	97	61	0.100
Analyte	1,1-Dichloroethane	75-34-3	1.0	5.0	100	80	120	70	120	80	120	30	ISTD1	63	65	83	0.200
Analyte	1,1-Dichloroethene	75-35-4	1.0	5.0	100	80	120	80	120	80	120	30	ISTD1	96	61	98	0.100
Analyte	1,1-Dichloropropene	563-58-6	1.0	5.0	100	80	125	75	120	80	125	30	ISTD1	75	110	77	
Analyte	1,2,3-Trichlorobenzene	87-61-6	1.0	5.0	100	80	120	80	125	80	120	30	ISTD3	180	145	109	
Analyte	1,2,3-Trichloropropane	96-18-4	1.0	5.0	100	80	120	70	120	80	120	30	ISTD3	75	110	61	
Analyte	1,2,4-Trichlorobenzene	120-82-1	1.0	5.0	100	80	120	80	125	80	120	30	ISTD3	180	182	145	0.200
Analyte	1,2,4-Trimethylbenzene	95-63-6	1.0	5.0	100	80	120	80	125	80	120	30	ISTD1	105	120	77	
Analyte	1,2-Dibromo-3-Chloropropane	96-12-8	1.0	5.0	100	70	120	70	120	70	120	30	ISTD3	157	155	75	0.050
Analyte	1,2-Dichlorobenzene	95-50-1	1.0	5.0	100	80	125	80	125	80	125	30	ISTD1	146	111	75	0.400
Analyte	1,2-Dichloroethane	107-06-2	1.0	5.0	100	70	120	70	120	70	120	30	ISTD1	62	64	98	0.100
Summary Analyte	1,2-Dichloroethene, Total	540-59-0	1.0	5.0	100	80	125	75	125	80	125	30	ISTD1	NA	NA	NA	
Analyte	1,2-Dichloropropane	78-87-5	1.0	5.0	100	80	125	75	120	80	125	30	ISTD1	63	76	41	0.100
Analyte	1,3,5-Trimethylbenzene	108-67-8	1.0	5.0	100	80	120	80	125	80	120	30	ISTD3	105	120	91	
Analyte	1,3-Dichlorobenzene	541-73-1	1.0	5.0	100	80	125	80	125	80	125	30	ISTD3	146	111	75	0.600
Analyte	1,3-Dichloropropane	142-28-9	1.0	5.0	100	80	125	75	120	80	125	30	ISTD2	76	41	49	
Analyte	1,4-Dichlorobenzene	106-46-7	1.0	5.0	100	80	125	80	120	80	125	30	ISTD3	146	111	75	0.500
Analyte	1,4-Dioxane	123-91-1	50	250	5000	75	140	75	120	75	140	30	ISTD1	88	58		
Analyte	2,2-Dichloropropane	594-20-7	1.0	5.0	100	80	120	75	120	80	120	30	ISTD1	77	97	61	
Analyte	2-Butanone (MEK)	78-93-3	5.0	10	500	60	170	60	130	60	170	30	ISTD1	72	43	57	0.100
Analyte	2-Chloro-1,3-butadiene	126-99-8	1.0	5.0	100	70	120	80	120	70	120	30	ISTD1	53	88	51	
Analyte	2-Chloroethyl vinyl ether	110-75-8	1.0	5.0	100	80	125	55	120	80	125	30	ISTD1	63	106	43	
Analyte	2-Chlorotoluene	95-49-8	1.0	5.0	100	80	125	80	125	80	125	30	ISTD3	91	126	75	
Analyte	2-Hexanone	591-78-6	1.0	5.0	500	75	150	80	120	75	150	30	ISTD2	43	58	85	0.100
Analyte	2-Methyl-2-propanol	75-65-0	50	50	5000	80	120	80	120	80	120	30	ISTD1	59	57	41	
Analyte	3-Chloro-1-propene	107-05-1	1.0	5.0	100	80	130	80	125	80	130	30	ISTD3	76	41	39	
Analyte	4-Chlorotoluene	106-43-4	1.0	5.0	100	80	125	80	125	80	125	30	ISTD3	91	126		
Analyte	4-Isopropyltoluene	99-87-6	1.0	5.0	100	75	120	75	120	75	120	30	ISTD3	119	91	134	
Analyte	4-Methyl-2-pentanone (MIBK)	108-10-1	5.0	5.0	500	80	125	75	130	80	125	30	ISTD1	43	58	85	0.100
Analyte	Acetone	67-64-1	5.0	5.0	500	15	200	70	120	15	200	30	ISTD1	58	43		0.100

Attachment 1: SW846 8260C Method Information (BR-MV-006)

Type	Analytes	CAS#	RL			Control Limits (%R)						Precision	Internal	Characterisitc Ion			Minimum RF
			Water	Soil	MeOH	Water		Low Soil		MeoH[1]		RPD	Standard				
			(ug/L)	(ug/Kg)	(ug/Kg)	Lower	Upper	Lower	Upper	Lower	Upper	≤	Association	Primary	Secondary	Tertiary	
Analyte	Acrolein	107-02-8	1.0	5.0	100	45	135	75	120	45	135	30	ISTD1	56	55		
Analyte	Acrylonitrile	107-13-1	1.0	5.0	100	75	140	80	120	75	140	30	ISTD1	53	52	51	
Analyte	Benzene	71-43-2	1.0	5.0	100	80	125	75	125	80	125	30	ISTD1	78	77		0.500
Analyte	Bromobenzene	108-86-1	1.0	5.0	100	80	125	75	120	80	125	30	ISTD3	156	77	158	
Analyte	Bromoform	75-25-2	1.0	5.0	100	80	120	75	120	80	120	30	ISTD2	173	175	171	0.100
Analyte	Bromomethane2	74-83-9	1.0	5.0	100	60	120	60	120	40	120	30	ISTD1	94	96		0.100
Analyte	Carbon disulfide	75-15-0	1.0	5.0	100	80	120	65	120	80	120	30	ISTD1	76	78		0.100
Analyte	Carbon tetrachloride	56-23-5	1.0	5.0	100	75	120	70	120	75	120	30	ISTD1	117	119	82	0.100
Analyte	Chlorobenzene	108-90-7	1.0	5.0	100	80	120	80	125	80	120	30	ISTD2	112	77	50	0.500
Analyte	Chlorobromomethane	74-97-5	1.0	5.0	100	80	130	75	120	80	130	30	ISTD1	130	49	128	
Analyte	Chlorodibromomethane	124-48-1	1.0	5.0	100	80	125	75	120	80	125	30	ISTD1	129	127	79	0.100
Analyte	Chloroethane	75-00-3	1.0	5.0	100	80	130	75	120	40	120	30	ISTD1	64	49	66	0.100
Analyte	Chloroform	67-66-3	1.0	5.0	100	75	120	80	120	75	120	30	ISTD1	83	85		0.200
Analyte	Chloromethane	74-87-3	1.0	5.0	100	65	120	65	120	65	120	30	ISTD1	50	52		0.100
Analyte	cis-1,2-Dichloroethene	156-59-2	1.0	5.0	100	80	125	75	120	80	125	30	ISTD1	61	96	98	0.100
Analyte	cis-1,3-Dichloropropene	10061-01-5	1.0	5.0	100	80	125	80	120	80	125	30	ISTD1	75	110	39	0.200
Analyte	Cyclohexane	110-82-7	1.0	5.0	100	80	120	70	120	80	120	30	ISTD1	84	56	69	0.100
Analyte	Dibromomethane	74-95-3	1.0	5.0	100	75	120	75	120	75	120	30	ISTD2	93	174	81	
Analyte	Dichlorobromomethane	75-27-4	1.0	5.0	100	80	120	75	120	80	120	30	ISTD1	83	85	47	0.200
Analyte	Dichlorodifluoromethane	75-71-8	1.0	5.0	100	35	125	55	120	35	125	30	ISTD1	75	71	8	0.100
Analyte	Ethyl ether2	60-29-7	1.0	5.0	5	40	120	40	120	40	120	30	ISTD1	60	29	7	
Analyte	Ethyl methacrylate	97-63-2	1.0	5.0	100	80	125	75	120	80	125	30	ISTD1	97	63	2	
Analyte	Ethylbenzene	100-41-4	1.0	5.0	100	80	125	80	125	80	125	30	ISTD2	100	41	4	0.100
Analyte	Ethylene Dibromide	106-93-4	1.0	5.0	100	80	120	75	120	80	120	30	ISTD1	106	93	4	0.100
Analyte	Hexachlorobutadiene	87-68-3	1.0	5.0	100	75	120	80	130	75	120	30	ISTD3	225	190	118	
Analyte	Iodomethane	74-88-4	1.0	5.0	100	45	150	55	125	45	150	30	ISTD1	142	127		
Analyte	Isobutyl alcohol	78-83-1	50	250	5000	80	130	75	130	80	130	30	ISTD1	43	41	42	
Analyte	Isopropyl ether2	108-20-3	1.0	5.0	100	40	120	40	120	40	120	30	ISTD1	45	87	59	
Analyte	Isopropylbenzene	98-82-8	1.0	5.0	100	80	120	80	125	80	120	30	ISTD3	105	120	77	0.100
Analyte	Methacrylonitrile	126-98-7	1.0	5.0	100	80	120	80	120	80	120	30	ISTD1	67	52	41	
Analyte	Methyl acetate	79-20-9	1.0	5.0	100	70	120	65	120	70	120	30	ISTD1	43	74	59	0.100
Analyte	Methyl methacrylate	80-62-6	1.0	5.0	100	80	125	75	120	80	125	30	ISTD2	69	41	100	
Analyte	Methyl tert-butyl ether	1634-04-4	1.0	5.0	100	80	120	70	120	80	120	30	ISTD1	73	43		0.100
Analyte	Methylcyclohexane	108-87-2	1.0	5.0	100	80	120	75	120	80	120	30	ISTD1	83	55	98	0.100
Analyte	Methylene Chloride	75-09-2	1.0	5.0	100	80	120	75	120	80	120	30	ISTD1	84	49	86	0.100
Analyte	m-Xylene & p-Xylene	179601-23-1	1.0	5.0	100	80	125	80	125	80	125	30	ISTD2	91	106	77	0.100
Analyte	Naphthalene	91-20-3	1.0	5.0	100	80	130	80	120	80	130	30	ISTD3	128			

Attachment 1: SW846 8260C Method Information (BR-MV-006)

Type	Analytes	CAS#	RL			Control Limits (%R)						Precision	Internal	Characterisitc Ion			Minimum RF
			Water	Soil	MeOH	Water		Low Soil		MeoH[1]		RPD	Standard				
			(ug/L)	(ug/Kg)	(ug/Kg)	Lower	Upper	Lower	Upper	Lower	Upper	≤	Association	Primary	Secondary	Tertiary	
Analyte	n-Butylbenzene	104-51-8	1.0	5.0	100	80	120	80	125	80	120	30	ISTD3	91	92	134	
Analyte	N-Propylbenzene	103-65-1	1.0	5.0	100	80	120	80	125	80	120	30	ISTD3	91	120	65	
Analyte	o-Xylene	95-47-6	1.0	5.0	100	80	120	80	125	80	120	30	ISTD1	91	106	77	0.300
Analyte	Propionitrile	107-12-0	4.0	20	400	80	135	80	120	80	135	30	ISTD1	54	53		
Analyte	sec-Butylbenzene	135-98-8	1.0	5.0	100	80	120	80	125	80	120	30	ISTD3	105	134	91	
Analyte	Styrene	100-42-5	1.0	5.0	100	80	120	80	125	80	120	30	ISTD2	104	78	51	0.300
Analyte	Tert-amyl methyl ether2	994-05-8	1.0	5.0	100	40	120	40	120	40	120	30	ISTD1	73	55	87	
Analyte	Tert-butyl ethyl ether2	637-92-3	1.0	5.0	100	40	120	40	120	40	120	30	ISTD1	59	87	57	
Analyte	tert-Butylbenzene	98-06-6	1.0	5.0	100	75	120	75	120	75	120	30	ISTD3	119	91	134	
Analyte	Tetrachloroethene	127-18-4	1.0	5.0	100	80	120	80	125	80	120	30	ISTD2	164	131	166	0.200
Analyte	Tetrahydrofuran	109-99-9	14	50.0	1400	80	120	75	120	80	120	30	ISTD1	42	71	72	
Analyte	Toluene	108-88-3	1.0	5.0	100	80	120	80	125	80	120	30	ISTD2	92	91	65	0.400
Analyte	trans-1,2-Dichloroethene	156-60-5	1.0	5.0	100	80	125	75	125	80	125	30	ISTD1	96	61	98	0.100
Analyte	trans-1,3-Dichloropropene	10061-02-6	1.0	5.0	100	80	120	75	120	80	120	30	ISTD2	75	110	49	0.100
Analyte	trans-1,4-Dichloro-2-butene	110-57-6	1.0	5.0	100	75	135	80	125	75	135	30	ISTD3	53	89	124	
Analyte	Trichloroethene	79-01-6	1.0	5.0	100	75	120	75	120	75	120	30	ISTD1	132	95	60	0.200
Analyte	Trichlorofluoromethane	75-69-4	1.0	5.0	100	75	120	65	120	40	120	30	ISTD1	101	103		0.100
Analyte	Vinyl acetate	108-05-4	1.0	5.0	100	80	200	80	185	80	200	30	ISTD1	43	86		
Analyte	Vinyl chloride	75-01-4	1.0	5.0	100	80	130	75	120	80	130	30	ISTD1	62	64		0.100
Summary Analyte	Xylenes, Total	1330-20-7	1.0	5.0	100	80	120	80	125	80	120	30	ISTD2	NA	NA	NA	
ISTD 1	Fluorobenzene	462-06-6	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ISTD 2	Chlorobenzene-d5	3114-55-4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ISTD 3	1,4-Dichlorobenzene-d4	3855-82-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Surrogate	1,2-Dichlorobenzene-d4	2199-69-1	NA	NA	NA	75	120	20	185	75	120	NA	ISTD3	152	115	154	
Surrogate	1,2-Dichloroethane-d4 (Surr)	17060-07-0	NA	NA	NA	80	120	35	145	80	120	NA	ISTD1	65	102		
Surrogate	4-BromoISTD1	460-00-4	NA	NA	NA	80	125	30	200	80	125	NA	ISTD3	95	174	176	
Surrogate	Toluene-d8 (Surr)	2037-26-5	NA	NA	NA	80	120	40	175	80	120	NA	ISTD2	98	70	100	

[1] *Water limits are used until sufficient number of points (30) are available to set in-house control limits. Some compounds are default limits based on known performance.*

2 *Default limits set until sufficient data points (30) available to set in-house limits.*

ATTACHMENT 2: Preparation Information Tables.

The forms attached to this SOP are copies of document controlled forms used in the laboratory.

Calibration, QC and Sample Preparation Information

8260B and 8260C Water (Prepared in 44 mL VOA Vial) - Use for Water and Medium Level Soil (MeOH)

Instructions: Add the amount, type and concentration of spiking solution listed in this table to a prepared 44 mL VOA vial.

SOP Reference: BR-MV-006

		Spiking Solutions							
		Routine						**Non-Routine**	
	Standard:	**524/8260**	**524/8260**	**8260**	**8260**	**TBA[1]**	**TBA[1]**	**Freon-123A**	**Freon-123A**
	Type:	**ISTD**	**SSTD**	**Cal Mix, Gases, & Addeds**	**LCS Mix, Gases, & Addeds**	**Cal**	**LCS**	**Cal**	**LCS**
Sample Type	**Conconcentration[2]**	**50 ug/mL**	**50 ug/mL**	**50 /250 ug/mL**	**50/250 ug/mL**	**2500 ug/mL**	**2500 ug/mL**	**50 ug/mL**	**25 ug/mL**
Level 1	**1 ug/L**	22 uL		0.9 uL		0.9 uL		0.9 uL	
Level 2	**5 ug/L**	22 uL		4.4 uL		1.8 uL		4.4 uL	
Level 3	**10 ug/L**	22 uL		8.8 uL		3.6 uL		8.8 uL	
Level 4 /CCV	**25 ug/L**	22 uL		**22 uL**		**8.8 uL**		**22 uL**	
Level 5	**50 ug/L**	22 uL		44 uL		17.6 uL		44 uL	
Level 6	**100 ug/L**	22 uL		88 uL		35.2 uL		88 uL	
ICV and LCS	**25 ug/L**	22 uL	22 uL		22 uL		8.8 uL		22 uL
MS / MSD	**25 ug/L**	22 uL	22 uL		22 uL		8.8 uL		22 uL
Samples & MB	**NA**	22 uL	22 uL						

1: tert-Butyl Alcohol

2: TBA concentration 20 fold greater, except Cal 1 which is 50 fold greater and Cal 3 which is 25 fold greater.

TALS Amounts: *TALS bases calculations on a VOA vial volume of 40 mL. The lab adds spikes and surrogates directly to 44 mL VOA vials. To compensate for the difference, the amount added in TALS must be an adjusted value. The conversion factor for 5 mL p*

Calibration, QC, and Sample Preparation Summary

8260B and 8260C Soil (Prepared in 44 ml / 5 mL VOA Vial)

Instructions: Add the amount, type and concentration of spiking solution listed in this table to a prepared 44 mL VOA vials and enter these amounts into the reagent worksheet in the TALS analysis batch.

SOP Reference: BR-MV-006

		Routine							
	Concentration$_2$	**524/8260 ISTD 50 ug/mL**	**524/8260 SSTD 50 ug/mL**	**8260 Cal Mix & Gases 200 ug/mL**	**8260 Cal Addeds 200 ug/mL**	**8260 LCS Mix & Gases 200 ug/mL**	**8260 LCS Addeds 200 ug/mL**	**TBA$_1$ 2500 ug/mL**	**TBA$_1$ LCS 2500 ug/mL**
Cal 1$_3$	**5 ug/L**	44 uL		1.1 uL	1.1 uL			0.9 uL	
Cal 2$_3$	**10 ug/L**	44 uL		2.2 uL	5.5 uL			1.8 uL	
Cal 3$_3$	**25 ug/L**	44 uL		5.5 uL	11 uL			3.6 uL	
Cal 4/CCV	**50 ug/L**	**5 uL**		**1.2 uL**	**3.1 uL**			**1 uL**	
Cal 5	**100 ug/L**	5 uL		2.5 uL	6.2 uL			2 uL	
Cal 6	**200 ug/L**	5 uL		5 uL	12.5 uL			4 uL	
ICV or LCS	**50 ug/L**	5 uL	5 uL			1.2 uL	3.1 uL		1 uL
MS / MSD	**50 ug/L**	5 uL	5 uL			1.2 uL	3.1 uL		1 uL
Samples & Blank	NA	5 uL	5 uL						

1: tert-Butyl Alcohol

2: TBA concentration 10 fold greater.

3: Prepared in 44 mL VOA vial.

TALS Amounts: *TALS bases calculations on a VOA vial volume of 40 mL. The lab adds spikes and surrogates directly to 44 mL VOA vials for some of the standards. To compensate for the difference, the amount added in TALS must be an adjusted value when the*

Title: Dissolved Gases in Groundwater
RSK-175

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Approval Date: August 1, 2012

Facility Distribution No. Electronic **Distributed To: Facility Intranet**

The controlled copy of this SOP is the PDF copy of the SOP that is posted to the laboratory's SOP Directory. Printed copies of this SOP or electronic copies of this SOP distributed outside the facility are considered uncontrolled.

1.0 Scope and Application

This SOP describes the laboratory procedure for the determination of dissolved gases (methane, ethane, ethene) and carbon dioxide in groundwater. This procedure determines the concentration of dissolved gas in headspace. This procedure does not provide total sample concentration (concentration in headspace + concentration in water).

This SOP provides the routine laboratory procedure; program specific or client specific requirements are not included in this SOP.

1.1 Analytes, Matrix(s), and Reporting Limits

The analytes that may be determined by this SOP and their associated reporting limits are:

Analyte	CAS Number	RL (ug/L)
Methane	000074-82-8	2
Ethane	000074-84-0	4
Ethene	000074-85-1	3
Carbon Dioxide	000124-38-9	1000

2.0 Summary of Method

Samples are collected without headspace in 44 mL VOA vials. Samples for methane, ethane, and ethene must be preserved with hydrochloric acid at the time of collection. Samples for carbon dioxide must be collected without preservation that would alter the pH of sample. Prior to analysis, a portion of sample is transferred to a 22 mL serum vial and headspace is created using nitrogen. Samples for methane, ethane, ethene are loaded onto a headspace autosampler and analyzed by GC/FID. Samples for carbon dioxide are manually injected and analyzed by GC/TCD.

This procedure is based on the following reference method:

- Method RSK-175, Revision 0, August 1994.

If the laboratory has modified this procedure from the reference method, a list of such modifications will be provided in Section 16.0 of this SOP.

3.0 Definitions

A list of terms and definitions are provided in Appendix A.

4.0 Interferences

Non-target compounds from the sample matrix can cause interference, which may result in positive identifications of non-target compounds with retention times similar to those of target compounds. The extent of these interferences will vary depending on the nature of the samples.

5.0 Safety

Employees must abide by the policies and procedures in the Corporate Environmental Health and Safety Manual (CW-E-M-001) and this document. This procedure may involve hazardous material, operations and equipment. This SOP does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of the method to follow appropriate safety, waste disposal and health practices under the assumption that all samples and reagents are potentially hazardous. Safety glasses, gloves, lab coats and closed-toe, nonabsorbent shoes are a minimum.

5.1 Specific Safety Concerns or Requirements

The gas chromatograph contains zones that have elevated temperatures. The analyst must be aware of the locations of those zones, and must cool them to room temperature prior to working on them.

There are areas of high voltage in the gas chromatograph. Depending on the type of work involved, either turn the power to the instrument off, or disconnect it from its source of power.

5.2 Primary Materials Used

The following table lists those materials that have a serious or significant hazard rating along with the exposure limits and primary hazards associated with that material as identified in the MSDS. A complete list of materials used in the method can be found Section 7.0. The table does not include all materials used in the procedure. Employees must review the information in the MSDS for each material before using it for the first time or when there are major changes to the MSDS.

Material (1)	Hazards	Exposure Limit (2)	Signs and Symptoms of Exposure
Hydrochloric Acid	Corrosive Poison	5 ppm-Ceiling	Inhalation of vapors can cause coughing, choking, inflammation of the nose, throat, and upper respiratory tract, and in severe cases, pulmonary edema, circulatory failure, and death. Can cause redness, pain, and severe skin burns. Vapors are irritating and may cause damage to the eyes. Contact may cause severe burns and permanent eye damage
1- Always add acid to water to prevent violent reactions			
2- Exposure limit refers to the OSHA regulatory exposure limit.			

6.0 Equipment and Supplies

Catalog numbers listed in this SOP are subject to change at the discretion of the vendor. Analysts are cautioned to be sure equipment used meets the specification of this SOP.

6.1 Miscellaneous

- Syringes: 10µL - 5.0 mL gas tight syringes with Luer-Lock tip, or equivalent
- Supply of UHP argon, helium, hydrogen, and nitrogen
- Acetylene 1%, Matheson, or equivalent
- Summa® Canister

6.2 Analytical System

- GC Acquisition Platform- VAX 4505 (GVAX) Multichrom V2.11. Data Processing-Hewlett-Packard 9000-series computers, an HP9000 D250 (Chemsvr4) and an HP9000 K200 (Chemsvr5)/HP-UX 10.20 and Target V3.5.
- GC-FID/TCD: Varian 3600 with FID and TCD
- Column: Alltech CTR-1, 6 ft x ¼ in. OD-SS (6 feet inner with porous polymer and 6 feet outer with molecular sieve).
- Column: Rt-Uplot, 30 m x 0.53 mmID
- Tekmar Headspace Autosampler, or equivalent

6.3 Sample Containers

- Serum vials with crimp top, 22mL
- 44 mL VOA vials

7.0 Reagents and Standards

7.1 Reagents

- VOA Free Reagent Water
- Hydrochloric Acid

7.2 Standards

- Primary Source Stock Standard: Matheson Micromat 14 (Grace Davison cat. #M7035) Gas Mix or equivalent. The Matheson Micromat 14 Gas Mix is comprised of 1% methane, ethane, ethene, carbon dioxide, acetylene, and carbon monoxide in nitrogen. Note: 1% is equivalent to 10,000 ppmv.
- Primary Source Stock Standard: Matheson Micromat 14 (Grace Davison cat. #M7006) Bone Dry carbon dioxide or equivalent. This mix contains 99.8% carbon dioxide in nitrogen. Note: 99.8% is equivalent to 980,000 ppmv.
- Second Source Stock Standards: Purchase a different lot of the primary source standard from

the manufacturer.

Use the primary and secondary source standards to prepare the calibration standards and QC samples. The recommended formulations for the calibration standards are provided in Section 10.2. The formulation to prepare the continuing calibration verification standard and QC samples are provided in Sections 10.0 and 11.0.

Prepare all standards as follows: Add reagent water to a 22 mL serum vial until brimming then cap the vial. Create headspace by injecting 4 mL of nitrogen or nitrogen w/ acetylene through the septum with a 5 mL gas-tight syringe. Invert the vial and inject the appropriate amount of standard through the septum into the water.

Nitrogen with Acetylene (0.5%): Using a gas tight syringe transfer 900 mL of 1% acetylene standard into a 6 L Summa canister. Pressurize the canister with nitrogen to 28.08092 psig, which corresponds to a final volume of 18.0 L.

Carbon Dioxide Working Standard (5%): Using a gas tight syringe transfer 912.2 mL of the primary source stock carbon dioxide standard into a 6 L Summa canister. Pressurize the canister with nitrogen to 29.99976 psig, which corresponds to a final volume of 18.2448 L. Use the same formulation to prepare the second source carbon dioxide working standard.

8.0 Sample Collection, Preservation, Shipment and Storage.

The laboratory does not perform or arrange for sample collection therefore these procedures are not included in this SOP.

The laboratory requires that samples for analysis of methane, ethane, and ethene be collected in 44 mL VOA vials preserved with 1:1 HCL to a pH of less than 2 at the time of collection. Samples for analysis of carbon dioxide must be collected in 44 mL VOA vials without preservative that would alter the pH. Immediately following collection, samples should be cooled and stored at 4° C ± 2° C until the time of analysis.

The holding time is 14 days from time of collection.

Unless otherwise specified by client or regulatory program, after analysis, samples are retained for a minimum of 30 days after provision of the project report and then disposed of in accordance with applicable regulations.

9.0 Quality Control

9.1 Sample QC

The laboratory prepares the following quality control samples with each batch of samples.

QC Item	Frequency	Acceptance Criteria
Method Blank (MB)	1 in 20 or fewer samples	See Table 1
Laboratory Control Sample (LCS)	1 in 20 or fewer samples	See Table 1
Matrix Spike(s) MS/MSD	Client Request	See Table 1

9.2 Instrument QC

The following instrument QC is performed:

QC Item	Frequency	Acceptance Criteria
Initial Calibration (ICAL)	Initially; when ICV or CCV fail	See Table 1
Second Source Calibration Verification (ICV)	Once, after each ICAL	See Table 1
Continuing Calibration Verification (CCV)	Daily, every 20 samples, end of sequence	See Table 1
Retention Time Window	As Needed, with ICAL	See Table 1

10. 0 Procedure

10.1 Instrument Operating Conditions

The recommended instrument operating conditions are as follows:

FID

Temperature Program:	40º for 3.5 minutes
FID Temperature:	200ºC
Injection Port Temperature:	50ºC
Carrier Gas:	Helium, 30 mL/min
Hydrogen (FID)	30 mL/min
Air (FID)	300 mL/min

TCD

Temperature Program:	75º for 3.5 minutes
TCD Temperature:	150ºC
Injection Port Temperature:	50ºC
Filament Temperature:	185ºC
Carrier Gas:	Hydrogen, 35 mL/min

Alternate operating conditions may be used however the operating conditions used for initial calibrations may not be changed until the next initial calibration.

10.2 Initial Calibration

Calibrate the instrument with a minimum of 5 calibration points for each analyte. The concentration of the lowest calibration standard must be less than or equal to established limit of quantitation (LOQ) for each analyte. Repeat initial calibration when the results of the initial or continuing calibration verification standard (ICV/CCV) indicate the calibration relationship is not valid.

The recommended concentration levels for each calibration level along with the corresponding volume of primary source standard needed to achieve these concentrations are as follows:

Concentration of ICAL Standards (ug/mL)

CAL	Injection Volume (uL)	Methane	Ethane	Ethene

Level 1	4.7	1.7	3.2	3.0
Level 2	50	18	34	32
Level 3	200	73	136	127
Level 4	600	218	409	381
Level 5	1000	363	681	636

Concentration of ICAL Standards (ug/mL)

CAL	Injection Volume (uL)	Carbon Dioxide
Level 1	200	1000
Level 2	500	2500
Level 3	1000	5000
Level 4	1500	7500
Level 5	2000	10000

$$ug/L = PPMV\ of\ Parent\ Standard \times \frac{MW(g)}{24.47} \times \frac{Volume\ Added(mL)}{18mL}$$

Where: ppmv = percent stock standard concentration multiplied by 10,000

Compound	Molecular Weight
Methane	16
Ethane	30
Ethene	28
Carbon Dioxide	44

The data processing system calculates the Calibration Factor (CF), mean CF and Percent Relative Standard Deviation (%RSD). The %RSD for each target analyte must be ≤ 30% for the initial calibration to be considered acceptable. If criteria are not met, perform corrective action prior to further analysis. Recommended corrective actions are provided in Table 1.

Immediately following initial calibration, verify the accuracy of the initial calibration with a second source verification standard (ICV).

To prepare the ICV for methane, ethane, ethene, add 200 uL of the second source standard into a 22 mL vial that contains 18 mL of VOA free water and 4 mL of headspace to yield an ICV concentration equivalent to the mid-point of the calibration.

To prepare the ICV for carbon dioxide, inject 1000 uL of the second source standard into a 22 mL vial that contains 18 mL of VOA free water and 4 mL of headspace to yield an ICV concentration equivalent to the mid-point of the calibration.

If after successful analysis of the ICV, time remains in the 24 hour analytical window samples may be analyzed without analysis of a continuing calibration verification standard (CCV); otherwise a CCV must be performed.

Trouble shooting:

Check the following items in case of calibration failures:

- ICAL: Perform injection port maintenance, change septum, check column and reference flows, recondition column, check oven and detector temperatures. In extreme cases, install new column, particularly if the chromatography has degraded as evidenced by peak shapes.
- ICV: Check standards quality, recalibrate.
- CCV: Perform injection port maintenance, change septum, check column and reference flows, recondition column, check oven and detector temperatures. In extreme cases, install new column, particularly if the chromatography has degraded as evidenced by peak shapes.

10.2.1 Continuing Calibration Verification (CCV)

Analyze a CCV each day before sample analysis and at the end of each analytical sequence. Prepare the CCV at a concentration equivalent to the mid-point of the calibration. The percent difference of the CCV must be ± 30%. If this criterion is not met, correct the problem and reanalyze the CCV. If that fails, recalibrate.

10.3 Sample Preparation

Remove the samples from the refrigerated storage and allow them to warm to room temperature.

Transfer the sample into a 22 mL vial with a crimp cap. Insert a 22-gauge needle into the septum. Using a 5 mL gas-tight syringe, inject 4 mL of UHP nitrogen or nitrogen with acetylene (methane, ethane, ethane) into the vial to create headspace. Withdraw the needle and syringe from the vial and shake vigorously for several seconds.

Check and record the pH of the sample used for analysis in the comment section of the run log or in the TALS batch. The pH for samples for methane, ethane and ethane should be <2. The pH for samples for carbon dioxide must be neutral. If pH is not within specifications, document the nonconformance with an NCM, notify the PM and wait for instruction. Do not proceed with analysis unless documented consent is received from the PM via the client.

To prepare a MS\MSD for methane, ethane, ethene, prepare two additional aliquots of the parent sample and add 200 uL of Matheson Micromat 14 Gas Mix into the headspace to yield a spike concentration equivalent to the mid-point of the calibration.

To prepare the method blank for methane, ethane, ethene, transfer 22 mL of VOA free reagent water into a 22 mL vial and seal with a crimp cap. Using a 5 mL gas-tight syringe, inject 4 mL of nitrogen with acetylene into the vial.

To prepare the LCS for methane, ethane, ethene, inject 200 uL of the second source standard into a 22 mL vial that contains 18 mL of VOA free water and 4 mL of headspace to yield an LCS concentration equivalent to the mid-point of the calibration.

To prepare a MS/MSD for carbon dioxide, prepare two additional aliquots of the parent sample and add 1 mL of 5% carbon dioxide working standard into the headspace to yield a spike concentration equivalent to the mid-point of the calibration.

To prepare the method blank for carbon dioxide, transfer 22 mL of VOA free reagent water into a 22 mL vial and seal with a crimp cap. Insert a 22-guage needle into the septum. Using a 5 mL gas-tight syringe, inject 4 mL of UHP nitrogen into the vial.

To prepare the LCS for carbon dioxide, inject 1 mL of the second source standard into a 22 mL vial that contains 18 mL of VOA free water and 4 mL of headspace to yield an LCS concentration equivalent to the mid-point of the calibration.

10.4 Analytical Sequence

An example analytical sequence including initial calibration is provided below. When samples are analyzed in the same analytical sequence as the initial calibration, an opening CCV is not required. When initial calibration is not part of the sequence, an ICV is not required; open the analytical window with a CCV followed by the LCS.

Injection Number	Lab Description
1	CAL LEVEL 1
2	CAL LEVEL 2
3	CAL LEVEL 3
4	CAL LEVEL 4
5	CAL LEVEL 5
6	ICV
7	LCS
8	Method Blank
9	SAMPLES
Final Injection	CCV

Establish the instrument operating conditions and calibrate the instrument in accordance with Section 10. If an acceptable initial calibration already exists, begin the sequence with analysis of the CCV.

For GC\FID analysis (methane, ethane, ethene), place the standards, samples, and method blanks onto the Tekmar headspace autosampler and initiate the sequence. The autosampler equilibrates the sample's water and headspace phases at 40º C and injects 100 uL of sample headspace onto the GC column, where target analytes, if present, are detected by the FID.

For GC\TCD analysis (carbon dioxide), manually inject 400 uL of the standards, samples, and method blanks directly onto the column.

11.0 Calculations/ Data Reduction

11.1 Qualitative Identification

The data processing system identifies the target analytes by comparing the retention time of the peaks to the retention times of the initial calibration standards.

11.2 Quantitative Identification

The data system calculates the concentration for each target analyte from the calibration curve using the equations given in Appendix B.

11.3 Calculations

See Appendix B.

11.4 Data Review

11.4.1 Primary Review (Performed by Primary Analyst)

Review the chromatography and quantiation in the data processing system to confirm quantitative and qualitative identification of each target analyte.

Upload the data files to TALS. Enter batch editor information and add the standards and reagents to the TALS batch. Review the results against acceptance criteria. If acceptance criteria are not met, make arrangements to perform corrective action.

Check the results of samples analyzed immediately after high concentration samples for signs of carry-over. Reanalyze the sample if carry over is suspected.

Dilute and reanalyze samples whose results exceed the calibration range. The diluted analysis should result in a determination within the upper half of the calibration curve.

Set results to primary, secondary, acceptable or rejected as appropriate.

Verify corrective action was taken for all results not within acceptance criteria. If corrective action is not taken or was unsuccessful, record all instances where criteria are not met with a nonconformance memo (NCM). Be sure to provide explanation of your decision making in the internal comment section of the NCM. The internal comment section should list the reason the NCM is suspected, which action (if any) was taken and why and the outcome of the action taken.

Review project documents such as the Project Plan (PP), Project Memo or any other document/process used to communicate project requirements to ensure those project requirements were met. If project requirements were not met, immediately notify the project manager (PM) to determine an appropriate course of action.

Set the batch to 1st level review.

11.4.2 Secondary Review (Performed by Peer Reviewer)

Review the project documents such as the Project Plan (PP), Project Memo or any other document/process used to communicate project requirements and verify project requirements were met. If project requirements were not met, immediately notify the project manager (PM) to determine an appropriate course of action.

Review the TALS batch editor to verify information is complete. Review the batch to verify that the procedures in this SOP were followed. If discrepancy is found, resolve the discrepancy and verify any modifications to the SOP are documented and approved.

Spot-check 15% of samples in the batch to verify quantitative and qualitative identification.

If manual integrations were performed:

- Review each manual integration to verify that the integration is consistent and compliant with the requirements specified in laboratory SOP BR-QA-005.

- Check to ensure an appropriate technical reason code is provided for each manual integration. Acceptable technical reason codes are provided in laboratory SOP BR-QA-005.

- Generate a “before” and “after” chromatogram for every manual integration performed on an instrument performance check standard (Tune, ICAL, ICV, CCV), QC sample (MB, LCS) and for any manual integration performed on any surrogate or internal standard in any field sample.

- Generate the Manual Integration Summary Report. Document your review of manual integrations on the summary report and obtain any review signatures of integrations performed during secondary review as required.

  If the reviewer disagrees with the integration performed by the primary analyst, the secondary data reviewer should not change the integration. Instead, he/she should consult with the primary analyst that performed the integration and both the reviewer and the primary analyst should agree the integration should be changed. If consensus between the primary analyst and the peer reviewer cannot be achieved; both should consult with the Technical Manager or department management for resolution. Any changes to the integration should be performed by the primary analyst. If it is necessary for the secondary reviewer to perform the manual integration because the primary analyst is out of the office; the integration made by the peer reviewer must be reviewed by another peer reviewer or by department management to verify the integration was performed and documented in compliance to SOP BR-QA-005. If the original analyst that performed the integration is out of the office, the data reviewer may consult with the Department Manager (DM), Department Supervisor (DS) or the Technical Manager (TM) to verify the change he/she thinks is needed is warranted and should be made.

Verify that the performance criteria for the QC items listed in Table 1 were met. If the results do not fall within the established limits verify that corrective actions were performed. If corrective action was not performed; verify the reason is provided and that the situation is properly documented with an NCM. Set samples to 2nd level review.

Run the QC checker and fix any problems found. Run and review the deliverable. Fix any problems found. When complete set the method chain to lab complete and forward any paperwork to report/project management.

11.5 Data Reporting

Data reporting and creation of the data deliverable is performed by TALS using the formatters set by the project manager during project initiation.

The following sections describe the default reporting scheme set for this method:

Analytical results above the reporting limit (RL) are reported as the value found. Analytical results less than the RL are reported as non-detect to the adjusted RL. The RL is adjusted for sample dilution/concentration. The unadjusted RL for each target analyte is provided in Section 1.

The laboratory does not report estimated values for this test method. Estimated values are results reported outside the established calibration range (results between the adjusted LOD and LOQ).

Electronic and hardcopy data are maintained as described in laboratory SOP BR-QA-014 Laboratory Records.

12.0 Method Performance

12.1 Detection Limit (DL), Limit of Detection (LOD) & Limit of Quantitation (LOQ)

Perform a DL study and verification at initial method set-up and when there is a significant change in instrumentation or procedure that affects the sensitivity of the method. See SOP BR-QA-005 for the procedure and requirements.

12.2 Demonstration of Capabilities (DOC)

Perform a method demonstration of capability at initial set-up and any time there is a significant change in instrumentation or procedure.

12.3 Training Requirements

Any employee that performs any portion of the procedure described in this SOP must have documentation in their employee training file that they have read this version of this SOP.

Instrument analysts, prior to independent analysis of client samples, must also have documentation of demonstration of initial proficiency (IDOC) and annual on-going proficiency (ODOC) in their employee training files.

13.0 Pollution Control

It is TestAmerica's policy to evaluate each method and look for opportunities to minimize waste generated (i.e., examine recycling options, ordering chemicals based on quantity needed, preparation of reagents based on anticipated usage and reagent stability). Employees must abide by the policies in Section 13 of the Corporate Safety Manual for "Waste Management and Pollution Prevention."

14.0 Waste Management

Waste management practices are conducted consistent with all applicable rules and regulations. Excess reagents, samples and method process wastes are disposed of in an accepted manner. Waste description rules and land disposal restrictions are followed. Waste disposal procedures are incorporated by reference to BR-EH-001.

The following waste streams are produced when this method is carried out:

- None

15.0 References/ Cross-References

- Method RSK-175, Revision 0, August 1994.

16.0 Method Modifications

Laboratory uses a procedural calibration and quantification of samples versus a calculation based on Henrys Law. The procedural calibration involves the preparation and analysis of calibration points using lab water spiked with the dissolved gases and analyzed using the same process used for field samples. The initial calibration utilizes a maximum %RSD criteria as opposed to a linear regression correlation coefficient similar to options provided in other environmental methodologies. The laboratory uses a CCV criteria of 30%D versus 20%D as detailed in the guidance Method. The procedural calibration also addresses the differences between the guidance method and the laboratories automated process used for the heating and shaking the samples. Calibration standards, QC samples, blanks, and field samples are all processed the same way. All samples are analyzed by an automated process that heats and hold each sample at a constant temperature prior to analysis eliminating the need to verify sample temperature every 4 hours. The laboratory SOP provides for a closing CCV at the end of each 24 hour analytical sequence demonstrating system control.

17.0 Attachments

- Table 1: QC Summary and Recommended Corrective Action
- Appendix A: Terms and Definitions
- Appendix B: Equations

18.0 Revision History

BR-AT-006, Revision 12:

Title Page: Updated approval signatures and copyright date
Section 11.4: Clarified data review procedure, content and responsibility.

Table 1: QC Summary and Recommended Corrective Action (EPA RSK-175)

[1] The recommended corrective action may include some or all of the items listed in this column. The corrective action taken may be dependent on project data quality objectives and/or analyst judgment but must be sufficient to ensure that results will be valid. If corrective action is not taken or is not successful, data must be flagged with appropriate qualifiers

QC Item	Frequency	Acceptance Criteria	Recommended Corrective Action[1]
ICAL	Before sample analysis, when CCVs indicate calibration is no longer valid, after major instrument maintenance	CF:RSD <30%	Correct problem, reanalyze, repeat calibration.
ICV	After each initial calibration	%R (70-130)	Correct problem and verify second source standard. If that fails, repeat initial calibration.
CCV	Every 24 hours and at the end of the sequence	%D ± 30%	Re-analyze once, if still outside criteria perform corrective action, sequence can be re-started if two successive CCVs pass, otherwise repeat ICAL and all associated samples since last successful CCV, unless CCV is high and bracketed samples are nondetects
MB	Every 20 samples	<RL	Examine project DQO's and take appropriate corrective action, which may include re-analysis of MB, re-extraction of batch, and/or non-conformance report (NCR). Corrective action must be documented on NCR. If there are no detects in samples, or if all detects are > 10 X MB level, re-prep and reanalysis may not be required
LCS	Every 20 samples	%R (70-130)	Examine project DQO's and take appropriate corrective action, which may include re-analysis of LCS, re-extraction of batch, and/or non-conformance report (NCR). Corrective action must be documented on NCR. Flag all reported values outside of control limits.
SD	SD per client request	RPD < 30	Examine project DQO's and take appropriate corrective action, which may include re-analysis of LCS, re-extraction of batch, and/or non-conformance report (NCR). Corrective action must be documented on NCR. Flag all reported values outside of control limits.

Appendix A: Terms & Definitions

Acceptance Criteria: specified limits placed on characteristics of an item, process or service defined in requirement documents.

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.

Analyte: The specific chemicals or components for which a sample is analyzed. (EPA Risk Assessment Guide for Superfund, OSHA Glossary).

Batch: environmental samples, which are prepared and/or analyzed together with the same process, using the same lot(s) of reagents. A preparation/digestion batch is composed of one to 20 environmental samples of similar matrix, meeting the above criteria.

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 the standards.

Calibration Curve: the graphical relationship between the known values or a series of calibration standards and their instrument response.

Calibration Standard: A substance or reference used to calibrate an instrument.

Continuing Calibration Verification (CCV): a single or multi-parameter calibration standard used to verify the stability of the method over time. Usually from the same source as the calibration curve.

Corrective Action: the action taken to eliminate the cause of an existing nonconformity, defect or other undesirable occurrence in order to prevent recurrence.

Data Qualifier: a letter designation or symbol appended to an analytical result used to convey information to the data user. (Laboratory)

Demonstration of Capability (DOC): procedure to establish the ability to generate acceptable accuracy and precision.

Holding Time: the maximum time that a sample may be held before preparation and/or analysis as promulgated by regulation or as specified in a test method.

Initial Calibration: Analysis of analytical standards for a series of different specified concentrations used to define the quantitative response, linearity and dynamic range of the instrument to target analytes.

Intermediate Standard: A solution made from one or more stock standards at a concentration between the stock and working standard. Intermediate standards may be certified stock standard solutions purchased from a vendor and are also known as secondary standards.

Laboratory Control Sample (LCS): a blank matrix spiked with a known amount of analyte(s) processed simultaneously with and under the same conditions as samples through all steps of the procedure.

Matrix Spike: A field sample to which a known amount of target analyte(s) is added.

Matrix Spike Duplicate: A second replicate matrix spike.

Method Blank (MB): a blank matrix processed simultaneously with and under the same conditions as samples through all steps of the procedure. Also known as the preparation blank (PB).

Method Detection Limit (MDL): 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 measurement system. The MDL is a statistical estimation at a specified confidence interval of the concentration at which relative uncertainty is ±100%. The MDL represents a range where qualitative detection occurs. Quantitative results are not produced in this range.

Non-conformance: an indication, judgment, or state of not having met the requirements of the relevant specification, contract or regulation.

Precision: The degree to which a set of observations or measurement of the same property, obtained under similar conditions, conform to themselves.

Preservation: Refrigeration and/or reagents added at the time of sample collection to maintain the chemical, physical, and/or biological integrity of the sample.

Quality Control Sample (QC): a sample used to assess the performance of all or a portion of the measurement system.

Reporting Limit (RL): the level to which data is reported for a specific test method and/or sample. The RL must be minimally at or above the MDL.

Appendix B: Equations

Percent Recovery (%R):

$$\%R = \frac{Cs}{Cn} \times 100$$

Where:
C_s = Concentration of the Spiked Field or QC sample
C_n = Nominal Concentration of Spike Added

Percent Recovery for MS/MSD (%R):

$$\%R = \frac{Cs - Cu}{Cn} \times 100$$

Where:
C_s = Concentration of the Spiked Sample
Cu = Concentration of the Unspiked Sample
C_n = Nominal Concentration of Spike Added

Relative Percent Difference (RPD):

$$RPD = \frac{C_1 - C_2}{\left(\frac{C_1 + C_2}{2}\right)} \times 100$$

Where:
C_1 = Measured Concentration of First Sample
C_2 = Measured Concentration of Second Sample

Calibration factor (CF):

$$CF_\chi = \frac{A_\chi}{C_\chi}$$

Where:
CF_χ = Calibration factor for analyte χ
A_χ = Peak area of analyte χ
C_χ = Concentration of analyte in standard

Mean Calibration Factor

$$\overline{CF} = \frac{\sum_{i=1}^{n} CF_i}{n}$$

Where: n= number of calibration levels

Standard Deviation of the Calibration Factor

$$SD = \sqrt{\frac{\sum_{i=1}^{n} \left(CF_i - \overline{CF}\right)^2}{n - 1}}$$

Relative Standard Deviation of the Calibration Factor (%RSD)

$$\%RSD = \frac{SD}{\overline{\overline{CF}}} \times 100$$

Percent Difference (CCV)

$$\%D = \frac{CF_V - \overline{CF}}{\overline{\overline{CF}}} \times 100$$

Where: CF_V = Calibration Factor from the CCV

Sample Concentration

$$\text{Concentration} = \frac{A_X}{CF_{AV}} \times DF$$

Where:
A_X = Peak area of analyte
CF_{av} = Mean calibration factor

Title: Percent Moisture Determination

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Facility Distribution No. Electronic **Distributed To: Facility Intranet**

The controlled copy of this SOP is the PDF copy of the SOP that is posted to the laboratory's SOP Directory. Printed copies of this SOP or electronic copies of this SOP distributed outside the facility are considered uncontrolled.

1.0 Scope and Application

This SOP describes the laboratory procedure for the determination of percent wet and dry weight.

1.1 Analytes, Matrix(s), and Reporting Limits

This procedure may be used to determine percent wet and percent dry weight in soil and solid materials.

2.0 Summary of Method

A 5-10 g portion of sample is dried for 12-24 hours in an oven maintained at a temperature of 105 ±2°C. After drying, the sample is cooled and re-weighed. Measurements are entered into the laboratory's LIMS (TALS) and percent moisture and percent solids is calculated by the LIMS.

3.0 Definitions

- Percent Dry Weight: The proportion of solid in a soil sample determined by drying an aliquot of the sample. Also known as percent solids.
- Percent Wet Weight: The proportion of moisture in a soil sample determined by drying an aliquot of the sample. Also known as percent moisture.
- A list of general laboratory terms and definitions are provided in Appendix A.

4.0 Interferences

None

5.0 Safety

Employees must abide by the policies and procedures in the Corporate Environmental Health and Safety Manual (CW-E-M-001) and this document. This procedure may involve hazardous material, operations and equipment. This SOP does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of the method to follow appropriate safety, waste disposal and health practices under the assumption that all samples and reagents are potentially hazardous. Safety glasses, gloves, lab coats and closed-toe, nonabsorbent shoes are a minimum.

5.1 Specific Safety Concerns or Requirements

None

5.2 Primary Materials Used

None

6.0 Equipment and Supplies

- Drying Oven: Capable of maintaining a temperature of 105 ±2°C.

- Aluminum Weigh Boats.

- Analytical Balance: Capable of measurements to 0.01 g.

7.0 Reagents and Standards

None

8.0 Sample Collection, Preservation, Shipment and Storage

Refer to the SOPs for the associated determinative analytical method.

9.0 Quality Control

The laboratory may prepare the following quality control samples with each batch of samples:

QC Item	Frequency	Acceptance Criteria
Sample Duplicate (SD)	1 per 20 samples	RPD (≤ 20)

10.0 Procedure

10.1 Calibration

Calibrate the balance on each day of use, prior to use, with at least two Class S weights that bracket the range of use. Record calibration in the laboratory logbook designated for this purpose.

Record the daily temperature measurement of the oven(s) in the form designated for this purpose.

10.2 Sample Preparation

Initiate a TALS batch and complete the batch information in Batch Editor. Scan the samples into the batch.

Label an aluminum dish with a numerical ID (1, 2, 3…) for each sample.

Weigh the aluminum dish using the analytical balance and upload the weight measurement to the TALS worksheet. To enter a weight measurement, move the cursor to the corresponding cell in the worksheet. When the balance displays the weight value, press the control bar on the balance until the display reads “Print”, and then release it immediately. The weight will appear in the worksheet, and the cursor will move to the next cell in the column.

Thoroughly mix the sample then measure 5-10 g of sample into the pre-weighed, pre-labeled aluminum dish. Weigh to the nearest 0.01 g and upload the weight measurement into the worksheet.

Place the dish in a drying oven maintained at a temperature of 105 ±2°C. Record the date and the time the samples were placed in the oven in Batch Editor and save the TALS batch.

Dry the sample for a minimum of 12 hours but not exceed 24 hours. After this time frame has elapsed, remove the samples from the oven and allow them to cool before weighing.

Open the TALS batch, reweigh the samples and upload the weight mesasurements. Record the oven temp and time out of the oven in Batch Editor.

NOTE: If the drying time is less than 12 hours (TAT is less than 24 hours), verify a constant weight by taking two measurements ~ 15 minutes apart. The minimum drying time should not be less than 4 hours. Constant weight is achieved when the difference between the two measurements is equal to or less than 0.01g.

NOTE: A single percent moisture and solid determination is performed per sample. The calculated percent wet or dry weight is applied to the parent samples, and any subsequent matrix spikes or sample duplicates.

11.0 Calculations / Data Reduction

11.1 Calculations

- $\text{Sample Dry Weight} = (\text{Dry Sample} + \text{Dish}) - \text{Dish}$
- $\text{Sample Wet Weight} = (\text{Wet Sample} + \text{Dish}) - \text{Dish}$

11.2 Data Review

Evaluate the results and if any sample has less than 50% solids immediately notify the Project Manager. Set the results to primary review.

11.2.1 Secondary Data Review

Spot check the calculations using the equations given in Section 11.1, set the results to 2nd level review and lab complete.

12.0 Method Performance

12.1 Method Detection Limit Study (MDL)

Not applicable.

12.2 Demonstration of Capabilities (DOC)

Not applicable.

12.3 Training Requirements

Any employee that performs any portion of the procedure described in this SOP must have documentation in their employee training file that they have read this version of this SOP.

13.0 Pollution Control

It is TestAmerica's policy to evaluate each method and look for opportunities to minimize waste generated (i.e., examine recycling options, ordering chemicals based on quantity needed, preparation of reagents based on anticipated usage and reagent stability). Employees must abide by the policies in Section 13 of the Corporate Safety Manual for “Waste Management and Pollution Prevention.”

14.0 Waste Management

Waste management practices are conducted consistent with all applicable rules and regulations. Excess reagents, samples and method process wastes are disposed of in an accepted manner. Waste description rules and land disposal restrictions are followed. Waste disposal procedures are incorporated by reference to BR-EH-001 Hazardous Waste.

The following waste streams are produced when this method is carried out.

- Solid Waste

Transfer the solid waste to the plastic bucket labeled solid waste located in your work area. The satellite containers are labeled “Hazardous Waste” along with the type of waste category generated. Authorized personnel routinely transfer the contents of the satellite containers to the hazardous waste storage room for future disposal in accordance with Federal, State and Local regulations.

15.0 References / Cross-References

- Statement of Work for Organic Analyses, Multi-Media, Multi-Concentration, Current Version, USEPA Contract Laboratory Approval Program.
- Statement of Work for Inorganic Analyses, Multi-Media, Multi-Concentration, Current Version, USEPA Contract Laboratory Approval Program.
- SW-846 Test Methods for the Evaluation of Solid Waste, Update III, December 1986.
- Corporate SOP CW-E-M-001 Corporate Environmental Health and Safety Manual
- Laboratory SOP BR-EH-011 Hazardous Waste
- Laboratory SOP BR-QA-014 Laboratory Records
- Laboratory Quality Assurance Manual (QAM)

16.0 Method Modifications

None

17.0 Attachments

- Table 1: Primary Materials Used
- Table 2: QC Summary & Recommended Corrective Action
- Appendix A: Terms and Definitions

18.0 Revision History

BR-WC-006, Revision 7:

- Title Page: Updated approval signatures
- Section 10: Added minimum drying time for rush TAT and added procedure for constant weight determination for samples with minimum drying time for rush TAT.

BR-WC-006, Revision 6:

- Title Page: Updated approval signatures. Changed title of SOP from percent solids to percent moisture.
- All Sections: Added language for percent wet weight and added reference to the new LIMS (TALS). Removed references to bench sheet and replaced with TALS worksheet. Inserted instructions for entry of results in TALS and initiation of TALS batch.
- Section 11.0: Changed primary and data review procedure to correlate with new LIMS procedures.

BR-WC-006, Revision 5:

- Title Page: Updated approval signatures.
- Converted SOP to new company template.
- Added procedure for acquiring weights directly from the balance to an excel spreadsheet in Section 10.2.

SOP Change in Progress Attachment (CIPA)

SOP Number	SOP Title	SOP Revision	SOP Effective Date	CIPA Effective Date
BR-WC-024	TOC in Soil	0	05/10/11	05/10/11

The following revisions were made to this standard operating procedure (SOP). These changes are effective as of the CIPA Effective Date. Changes to this document will be incorporated into the document with the next revision. This document change is authorized and issued by the laboratory's QA Department.

Section 7.2: Add the following text to this section:

- Potassium Hydrogen Phthalate (KHP) (Primary Standard Grade) Used to calibrate the instrument. 47.05% Carbon by weight

<u>1% Carbon KHP Solution (10,000 mg Carbon/L)</u>: Add 50 mL of reagent water to a 100 mL volumetric flask. Add 2.128 g of KHP and dissolve completely. Adjust to final volume with reagent water. To mix the solution, cap the flask and invert. Allow the air bubble to reach the top of the flask. Repeat 9 times. Assign an expiration of 6 months from the date prepared and store at room temperature.

<u>0.1% Carbon KHP Solution (1000mg Carbon/L)</u>: Add approximately 25 mL of reagent water to a 50 mL volumetric flask. Add 5 mL of 1 % Carbon KHP solution to the flask and adjust to final volume with reagent water. To mix the solution, cap the flask and invert. Allow the air bubble to reach the top of the flask. Repeat 9 times. Assign an expiration date of 6 months from the date prepared so long as the parent solution does not expire sooner, in which case use the earliest expiration date. Store the solution at room temperature.

<u>0.01% Carbon KHP Solution (100mg Carbon/L)</u>: Add approximately 25 mL of reagent water to a 50 mL volumetric flask. Add 0.5 mL of 1% Carbon KHP Solution and adjust to final volume with reagent water. To mix the solution, cap the flask and invert. Allow the air bubble to reach the top of the flask. Repeat 9 times. Assign an expiration date of 6 months from the date prepared so long as the parent solution does not expire sooner, in which case use the earliest expiration date. Store the solution at room temperature.

Section 9.1: Change the LCS and MS acceptance criteria to 75-125%R.

QC Item	Frequency	Acceptance Criteria
Method Blank (MB)	1 in 20 or fewer samples	< RL
Laboratory Control Sample (LCS)	1 in 20 or fewer samples	%R ~~85-115~~ 75-125
Sample Duplicate (DP)	Client Request	RPD (≤ 20)
Matrix Spike (MS)	Client Request	%R ~~85-115~~ 75-125

Section 10.1: Replace the table in this section with the following table:

Calibration Standards	1.0% C KHP uL	0.1% C KHP uL	0.01%C KHP uL	% Carbon KHP	Carbon (mg)	mg/Kg of Carbon (10mg sample)
Level 1	0	0	0	47.05	0	0
Level 2	0	0	100	47.05	0.010	1000
Level 3	0	40	0	47.05	0.040	4000
Level 4	25	0	0	47.05	0.25	25000
Level 5	50	0	0	47.05	0.500	50000
Level 6	75	0	0	47.05	1.000	75000

Title: TOC in Soil

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The controlled copy of this SOP is the PDF copy of the SOP that is posted to the laboratory's SOP Directory. Printed copies of this SOP or electronic copies of this SOP distributed outside the facility are considered uncontrolled.

1.0 Scope and Application

This SOP describes the laboratory procedure for the determination of total organic carbon (TOC) and black carbon in soils, sediments and other solids.

The procedure for TOC in soils and sediments is provided in the main body of this SOP. The procedure for the determination of TOC in marine sediment high in inorganic carbon is provided in Appendix B and the procedure for black carbon is provided in Appendix D.

1.1 Analytes, Matrix(s), and Reporting Limits

This procedure may be used to determine percent dry weight in soil and solid materials.

The routine reporting limit is 1000 mg/kg based on an initial sample weight of 10 mg. Additional weight of sample may be used (up to 25 mg) to achieve as low a reporting limit as 500 mg/kg.

2.0 Summary of Method

A 10 mg aliquot of sample is transferred to a tin capsule, treated with phosphoric acid and dried in an oven at a temperature 105°C for 30 minutes to one hour in order to separate the organic carbon from inorganic carbonates and bicarbonates. The sample is analyzed on an instrument where it is pyrolyzed in an inductive type furnace. The carbon is converted to carbon dioxide and measured by a differential thermal conductivity detector.

This procedure is based on the following reference documents:

- EPA Region II Document Determination of Total Organic Carbon in Sediment, July 27, 1998, authored by Lloyd Kahn, Quality Assurance Specialist.
- Dixon, Wilfrid J., and Massey, Frank J. Jr.: Introduction to Statistical Analysis (fourth edition). Edited by Wilfrid J. Dixon. McGraw-Hill Book Company, New York, 1983. P377 and P548.

The procedure in this SOP for total organic carbon is modified from the above reference method. The procedures for black carbon and marine sediment are not based on a method and should be considered laboratory derived methods.

3.0 Definitions

A list of general laboratory terms and definitions are provided in Appendix A.

4.0 Interferences

Volatile organics in the sediments may be lost in the decarbonation step resulting in a low bias.

5.0 Safety

Employees must abide by the policies and procedures in the Corporate Environmental Health and Safety Manual (CW-E-M-001) and this document. This procedure may involve hazardous material, operations and equipment. This SOP does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of the method to follow appropriate safety, waste disposal and health practices under the assumption that all samples and reagents are potentially hazardous. Safety glasses, gloves, lab coats and closed-toe, nonabsorbent shoes are a minimum.

5.1 Specific Safety Concerns or Requirements

None

5.2 Primary Materials Used

Table 1 lists those materials used in this procedure that have a serious or significant hazard rating along with the exposure limits and primary hazards associated with that material as identified in the MSDS. The table does not include all materials used in the procedure**.** A complete list of materials used can be found in section 7.0. Employees must review the information in the MSDS for each material before using it for the first time or when there are major changes to the MSDS. Any questions regarding the safe handling of these materials should be directed to the laboratory’s Environmental Health and Safety Coordinator.

6.0 Equipment and Supplies

- Drying Oven: Capable of maintaining a temperature of 105 ±2°C.
- Carlo Erba Elemental Analyzer Model EA1108 and Model NA 1500 or equivalent.
- Costech Elemental Analyzer: Model 4010 or equivalent.
- Analytical Balance: Capable of weighing to the nearest 0.001mg.
- Aluminum Weigh Boats.
- Tweezers
- 5mm X 9mm tin capsules
- Quartz Columns: Costech Analytical or equivalent.
- Quartz wool: for segregating and containing column materials
- Copper Wire, Reduced: Costech Analytical or equivalent.
- Tungsten on Alumina: Costech Analytical or equivalent.
- High Temperature Gloves
- Clear Plastic Sample Trays: Costech Analytical or equivalent.

7.0 Reagents and Standards

7.1 Reagents

- Reagent water

- Phosphoric Acid, Concentrated: Reagent Grade, J.T. Baker recommended.

Phosphoric Acid Solution (1:19): Add approximately 100 mL of reagent water to a 200 mL volumetric flask. Add 18.34 g of concentrated phosphoric acid to the volumetric flask then adjust to volume with reagent water. Mix the solution well then transfer the solution to a 250 mL polyethylene bottle. Assign an expiration date of six months from date made and store the solution at room temperature.

7.2 Standards

- Acetanilide Crystals of known Carbon percentage: Purchased from Costech Analytical. Used to check instrument calibration.

- Sulfanilamide Crystals (41.84% Carbon): Purchased from Costech Analytical. This material is used to calibrate the instruments.

- Laboratory Control Samples (LCS) Material, Organic Material of known Carbon percentage: Purchased from LECO Corporation.

- Matrix Spike Material, 1632B trace elements in coal (76.86% Carbon)

8.0 Sample Collection, Preservation, Shipment and Storage

The laboratory does not perform sample collection so sampling procedures are not included in this SOP. Sampling requirements may be found in the published reference method.

Listed below are the laboratory recommended minimum sample size, preservation and holding time requirements:

Parameter	Sample Container	Minimum Sample Size	Preservation	Holding Time[1]	Reference
Total Organic Carbon	Amber glass	10 g	Chilled to $\leq$ 4°C	14 Days	TOC by Lloyd Kahn
Black Carbon	Amber glass	10 g	Chilled to $\leq$ 4°C	None	None

[1] Holding time is determined from date of collection.

Unless otherwise specified by client or regulatory program, after analysis, samples and extracts are retained for a minimum of 30 days after provision of the project report and then disposed of in accordance with applicable regulations.

9.0 Quality Control

9.1 Sample QC

The laboratory prepares the following quality control samples with each batch of samples.

QC Item	Frequency	Acceptance

		Criteria
Method Blank (MB)	1 in 20 or fewer samples	< RL
Laboratory Control Sample (LCS)	1 in 20 or fewer samples	%R (85-115)
Sample Duplicate (DP)	Client Request	RPD (≤ 20)
Matrix Spikes (MS)	Client Request	%R (85-115)

9.2 Instrument QC

The laboratory analyzes the following instrument check standards:

QC Item	Frequency	Acceptance Criteria
Initial Calibration (ICAL)	Initial Method Set-Up, after combustion chamber is changed (approx. every 200 drops)	Correlation coefficient must be >0.995
Calibration Verification (Acetanilide)	Every 20 drops and at the end of the analytical sequence	%R (85-115)
Calibration Blank (CCB)	After every acetanilide	<RL

10.0 Procedure

10.1 Calibration

Analyze a calibration curve each time the combustion column is changed. Change the column after 200 drops or when you experience result issues or odd peak shapes or baseline issues. The column change procedure is provided in Appendix C.

The recommended formulations for each calibration level are provided in the following table:

Calibration Standard Sulfanimide	Weight[1] (mg)	% Carbon	Carbon (mg)
Calibration Level 1	0.100	41.84	0.0418
Calibration Level 2	0.500	41.84	0.2092
Calibration Level 3	1.00	41.84	0.4184
Calibration Level 4	1.50	41.84	0.6276
Calibration Level 5	1.75	41.84	0.7322

[1] These weights are approximate. Enter the actual weight used into the software program.

Measure a single drop for each calibration point. The instrument software system plots peak area against mg of Carbon and calculates a correlation coefficient using standard linear regression. The correlation coefficient (r) must be $\geq$ 0.995 for the calibration to be considered acceptable. If it is not, repeat the calibration prior to further analysis.

1.0 Troubleshooting

- Calibration passes at > 0.995 correlation, but LCS fails abnormally low: Re-calibrate. Calibration usually needs to be > 0.999 correlation.

- Carbon peak “maxes out” at instrument 1200mv (peak has flat top): Reanalyze sample at lower weight.

- No peaks on any chromatograms, no results: Gases to instrument may be off. Turn on all gasses at valve manifold.

- Autosampler will not work at all: Gasses to instrument may be off. Turn on all gasses at valve manifold.

- Single chromatogram shows results at bottom of page, but no peak or baseline in chromatogram window: Re-print single chromatogram.

- Some or all chromatograms show carbon peak at same retention time as Acetanilide, but peak is not identified as carbon, or is identified as another element: Retention time shifted. Adjust retention time in calibration window, and reprint chromatograms.
- Upon recalibration, peaks are not being identified as carbon: In calibration window, general tab, adjust retention time to match peaks. Starting at level 1, “Open Standard”, open level1 curve pt. in calibration directory, click “Add Peak” button, click on peak itself. Increase level #, opening standard for each curve pt and add each peak. Carbon Tab should have all five calibration points on curve, if done correctly.
- Peaks in chromatograms identified as carbon, but all results in summary table below chromatogram are zero: Current calibration not associated with run when started. Open current calibration, copy first two columns for all points (5 rows) in small table in general tab. Then, open calibration that was associated with run (should be empty) and paste into table in calibration tab. Reprint all chromatograms on run.
- Software crashes during analysis: Boot up software normally. Chromatograms already printed/analyzed are ok, but, sample that was analyzing during shutdown is lost. Restart table at next sample by un-checking “run” box for samples already run and sample that was lost.

- Autosampler error causes few samples to remain in autosampler tray after run has finished: Identify samples that got stuck. Create a new run and analyze stuck samples (with initial weights) with bracketing QC. No PBS/LCS needed.
- Autosampler error causes many sequential samples to remain in autosampler tray after run has finished (usually end of run): Add rows onto existing table. Identify samples that did not get analyzed and repeat Ids and weights into added rows. Restart table. All analyzed samples’ status should be blue (analyzed), added rows should be green (not analyzed yet).
- Various result issues or odd peak shapes or baseline issues: Column may be leaking or cracked. Change column, recalibrate.

10.3 Sample Preparation

Using tweezers, and working directly from the box, place a tin capsule on the analytical balance and tare the balance. Using the small sample scoop, add approximately 10 mg (or the project specified sample weight) of sample to the capsule. Record the actual sample weight used on sample preparation log. Remove the capsule from the balance and place into one of the aluminum holding trays. Weigh two additional portions of sample into two separate tin capsules for each field sample.

To prepare the method blank, set two empty tin capsules into an aluminum holding tray.

To prepare the LCC, weigh ~9 mg of the LECO LCS material into two separate tin capsules and set them in sequence in an aluminum holding tray.

For the matrix spike, weigh out an additional sample aliquot and record its weight. Add 0.3 – 0.7 mg of matrix spike material and record this weight.

For the sample duplicate, weigh out an additional sample aliquot. Prepare two aliquots for both the matrix spike and the sample duplicate.

Add two drops of 1:19 phosphoric acid to each tin capsule. Place the aluminum trays into a drying oven set to a temperature of 105ºC for 30-60 minutes or until all samples appear dry.

Using tweezers pinch the top of each tin capsule closed and compress the capsule around the material inside. Work carefully so as not to tear the capsule, but crush it down to the smallest size. Set the prepared samples in line in a clear plastic sample tray for storage, or place directly into an autosampler tray for analysis. For the latter, leave positions open for the acetanilide check standards and associated calibration blanks.

Prepare the acetanilide standard and blanks as follows:

For each acetanilide spike, weigh ~0.5 mg of acetanilide material into a tin capsule. Fold the capsule up and compress down to the smallest size possible. Prepare enough acetanilide to ensure a frequency of every 20 drops and the end of the analytical sequence. For each associated calibration blank, leave an empty position in the autosampler tray.

Software Set-up and Analysis

If the column has been changed generate a new calibration curve. If not, use the existing calibration curve for analysis. Each column will analyze approximately 200 individual sample drops. When the counter on the instrument approaches 200, watch the instrument data for signs that the column is deteriorating; poor peak resolution, trailing baselines, extraneous peaks. If a column change is necessary, refer to Appendix C for the procedure. After changing the column, generate a new calibration curve.

Select the appropriate channel: Channel 1 is the NA 1500, Channel 2 is the EA 1108, and Channel 3 is the Costech instrument, which has its own PC. At the main screen select the sample table icon. The last sample table that was run will be shown on the screen.

Open a new sample table, and select the appropriate number of sample positions for the analysis, then name the table with the date and a unique alpha designator (i.e. 061505a). In front of the %3r in the file name column of the sample table, add the sample table name to ensure that each individual chromatogram generated from this sample table has a unique filename associated with it.

If the combustion column has been changed and instrument needs to be calibrated, follow the procedure below:

Prepare a “bypass” drop to determine the retention time for carbon with the new column. The bypass is an aliquot of acetanilide. The weight is not needed. Drop the bypass into the instrument and initiate a singular analysis. Set the retention time for carbon in the software to match that of the bypass drop.

Identify the first five sample lines with the names Std1 through Std 5. Enter their respective weights in the weight column, assign them a level # in the level column (Std1 is level 1, Std2 is level 2, etc.) to alert the software the order in which to place the calibration standards. In the sample type column, use the drop down and select "standard" for each. Finally, use the drop down in the Standard name column and select "sulfanilamide" for each. Add the standards to the autosampler tray and hit "start" to run the calibration.

Sample Analysis:

Open a new sample tray and create a unique file name. When the instrument was last calibrated, the software creates a calibration file with the same name as the sample table in which it was run. Open this file and save it with the same name as the sample table about to be run to ensure that the analysis is calculated from the most recent calibration. To do this, click on the calibration icon (looks like a little calibration curve) and use the file option to open the calibration file last performed. Save this file with the same name as your sample table. Click on the sample table icon (looks like a little sample table) to get back to your sample table.

Enter each sample ID and their respective weights and save the sample table. Enter a weight of 10 mg for the Method Blank (PBS) and instrument blanks.

An example analytical sequence follows:

Initial Calibration (calibration blank and 5 calibration standards)

Acetanilide	(1 drop)
Blank	(1 drop)
PBS	(2 individual drops)
LCS	(2 individual drops)
Sample	(2 individual drops)
Sample	(2 individual drops)
Sample	(2 individual drops)
Sample	(2 individual drops)
Sample	(2 individual drops)
Sample	(2 individual drops)
Sample	(2 individual drops)
Sample	(2 individual drops)
Acetanilide	(1 drop)
Blank	(1 drop)

Add the samples and acetanilides to the autosampler tray and set the tray into the autosampler carriage. Turn the autosampler tray until the number 1 position is behind the post, in front of the autosampler. The tray is now set to run.

Click the "start" icon to begin the analysis.

After analysis review the analytical results against the acceptance criteria given in Table 2, Section 18.0, and perform corrective action as necessary. Report results in mg/kg Carbon and corrected for % solids.

11.0 Calculations / Data Reduction

11.1 Calculations

11.2 Percent Carbon to mg/kg Carbon Conversion

% Carbon × 10,000 = mg/kg Carbon

11.3 LCS Percent Recovery (%R)

$$\%R = \frac{\text{LCS Result}}{\text{LCS True Value}} \times 100$$

11.4 MS Percent Recovery (%R)

$$\text{mg/Kg wet SA} = \frac{\text{Spike TV} \times \text{weight of MS added}}{\text{sample weight}} \times 1\,\text{million}$$

$$\text{mg/Kg dry SA} = \frac{\text{mg/Kg wet SA}}{\%\ \text{solid}} \times 100$$

$$\text{mg/Kg dry Carbon} = \frac{\text{mg/Kg wet Carbon (from instrument)}}{\%\ \text{solid}} \times 100$$

$$\%R = \frac{A - B}{C} \times 100$$

Where:
A= Average of two drops of MS sample result: mg/Kg dry carbon
B= Average of two drops of parent sample: mg/Kg dry carbon
C= Average of two drops of mg/Kg dry SA
SA= spike added (mg/Kg)
Spike TV= 0.7686 (mg/Kg)

11.5 Relative Percent Difference (RPD)

$$\text{RPD} = \frac{|D_1 - D_2|}{\frac{D_1 + D_2}{2}} \times 100$$

Where:

D_1 = First Sample Value

D_2 = Second Sample Value (duplicate)

11.6 Dixon Test (Use 3-7 results)

1. Sort all the results in ascending order (low values to high).
2. Calculate the tau statistic for the low and high values.
3. Compare the calculated tau statistics (low and high) to critical values listed below.
4. If either calculated tau is higher than the critical value, reject that value and repeat the test.

Tau statistic for lowest value = $\tau_L = (X_2 - X_1) / (X_k - X_1)$
Tau statistic for highest value = $\tau_H = (X_k - X_{k-1}) / (X_k - X_1)$

Where:
X_2 = Second lowest value in sorted list.
X_1 = Lowest value in sorted list.
X_k = Highest value in sorted list.
X_{k-1} = Second highest value in sorted list.

Number of observations, k	Critical Values
3	0.941
4	0.765
5	0.642
6	0.560
7	0.507

11.2 Data Review

12.0 Method Performance

13.0 Pollution Control

It is TestAmerica's policy to evaluate each method and look for opportunities to minimize waste generated (i.e., examine recycling options, ordering chemicals based on quantity needed, preparation of reagents based on anticipated usage and reagent stability). Employees must abide by the policies in Section 13 of the Corporate Safety Manual for "Waste Management and Pollution Prevention."

14.0 Waste Management

Waste management practices are conducted consistent with all applicable rules and regulations. Excess reagents, samples and method process wastes are disposed of in an accepted manner. Waste description rules and land disposal restrictions are followed. Waste disposal procedures are incorporated by reference to BR-EH-001 *Hazardous Waste*.

The following waste streams are produced when this method is carried out.

- Caustic waste – 2.5 L glass satellite container.
- Acidic Waste - 2.5L glass satellite container

The satellite containers are labeled “Hazardous Waste” along with the type of waste category generated. Authorized personnel routinely transfer the contents of the satellite containers to the hazardous waste storage room for future disposal in accordance with Federal, State and Local regulations.

15.0 References / Cross-References

- EPA Region II Document Determination of Total Organic Carbon in Sediment, July 27, 1998, authored by Lloyd Kahn, Quality Assurance Specialist.
- Dixon, Wilfrid J., and Massey, Frank J. Jr.: Introduction to Statistical Analysis (fourth edition). Edited by Wilfrid J. Dixon. McGraw-Hill Book Company, New York, 1983. P377 and P548.
- Corporate SOP CW-E-M-001 Corporate Environmental Health and Safety Manual
- Laboratory SOP BR-QA-005, Procedures for the Determination of Limits of Detection (LOD), Limits of Quantitation (LOQ) and Reporting Limits (RL).
- Laboratory SOP BR-QA-011 Employee Training
- Laboratory SOP BR-EH-011 Hazardous Waste
- Laboratory SOP BR-QA-014 Laboratory Records
- Laboratory Quality Assurance Manual (QAM)

16.0 Method Modifications

The laboratory procedure is modified from the reference method as follows:

Modification Number	Method Reference	Modification
1	TOC by Lloyd Kahn	The laboratory analyzes two drops per sample and if the RPD is greater than 40% the Dixon test is utilized.

17.0 Attachments

- Table 1: Primary Materials Used
- Table 2: QC Summary & Recommended Corrective Action
- Appendix A: Terms and Definitions
- Appendix B: TOC Procedure for High Concentration Marine Sediments (CITHON)
- Appendix C: Column change procedure
- Appendix D: Determination of Black Carbon in Sediment Procedure

18.0 Revision History

BR-WC-0024, Revision 0:

This is the first version of this SOP.

Table 1: Primary Materials Used

Material (1)	Hazards	Exposure Limit (2)	Signs and symptoms of exposure
Phosphoric Acid	Corrosive	1 Mg/M3 TWA	Inhalation is not an expected hazard unless misted or heated to high temperatures. May cause redness, pain, and severe skin burns. May cause redness, pain, blurred vision, eye burns, and permanent eye damage.
1 – Always add acid to water to prevent violent reactions.			
2 – Exposure limit refers to the OSHA regulatory exposure limit.			

Table 2: QC Summary, Frequency, Acceptance Criteria and Recommended Corrective Action

QC Item	Frequency	Acceptance Criteria	Recommended Corrective Action[1]
ICAL	Following each column change	correlation coefficient $\geq$ 0.995	Standards check, re-calibration
Acetanilide	Every 20 drops and at the end of the analytical run	%R (85-115)	Re-prepare and reanalyze samples not bracketed by passing standard.
Blank (paired with Acetanilide)	Following each Acetanilide	< RL	Re-prepare and reanalyze batch.
Method Blank (MB)	Once per batch of 20 samples	< RL DoD: ½ RL	Re-prepare and reanalyze batch.
LCS	Once per batch of 20 samples	%R (75-125)	Re-prepare and reanalyze batch.
Sample Duplicate (DP)	One per batch of 20 or less samples	RPD (≤ 20)	Discuss outlier in project narrative
MS/MSD	One per batch of 20 or less samples	%R (75-125)	Discuss outlier in project narrative
Sample precsion	Each sample is run in duplicate	%RPD<40%	Analyze 2 more replicates and perform Dixon test for high and low outliers. Include Dixon spreadsheet in the data package and narrative note results.

[1] The recommended corrective action may include some or all of the items listed in this column. The corrective action taken may be dependent on project data quality objectives and/or analyst judgment but must be sufficient to ensure that results will be valid. If corrective action is not taken or is not successful, data must be flagged with appropriate qualifiers.

Appendix A: Terms and Definitions

Batch: environmental samples, which are prepared and/or analyzed together with the same process, using the same lot(s) of reagents. A preparation/digestion batch is composed of one to 20 environmental samples of similar matrix, meeting the above criteria.

Calibration: the establishment of an analytical curve based on the absorbance, emission intensity or other measured characteristic of known standard.

Calibration Standards: a series of known standard solutions used to calibrate the instrument response with respect to analyte concentration. A standard containing the analyte in question (sulphanilimide) is prepared at varying weights and analyzed. This standard is a separate source from the LCS. The sulphanilimide is used to calibrate the instrument response with respect to analyte concentration.

Demonstration of Capability (DOC): procedure to establish the ability to generate acceptable accuracy and precision.

Holding Time: the maximum time that a sample may be held before preparation and/or analysis as promulgated by regulation or as specified in a test method.

Laboratory Control Sample (LCS): a blank matrix spiked with a known amount of analyte(s) processed simultaneously with and under the same conditions as samples through all steps of the procedure.

Matrix Duplicate (DP): duplicate aliquot of a sample processed and analyzed independently; under the same laboratory conditions; also referred to as Sample Duplicate.

Method Blank (MB): a blank matrix processed simultaneously with and under the same conditions as samples through all steps of the procedure. Also known as the preparation blank (PB).

Non-conformance: an indication, judgment, or state of not having met the requirements of the relevant specification, contract or regulation.

Preservation: refrigeration and/or reagents added at the time of sample collection to maintain the chemical, physical, and/or biological integrity of the sample.

Reporting Limit (RL): the level to which data is reported for a specific test method and/or sample.

Appendix B: Marine Sediments High in Inorganic Carbon

Sample Preparation

Transfer approximately 10 g of a thoroughly mixed sample to an aluminum weigh dish, and dry in the 105°C oven. Grind the sample with the pink mortar and pestle to a fine powder. Record the weight of a 250 mL Teflon beaker then transfer ~ 5 g of the ground sample to this beaker.

If the sample is to be spiked, weigh the beaker to the nearest 0.1mg and record the weight. Likewise determine and record the weight of the added sample. Add 0.1g of NIST 1632b Trace Elements in Coal (80.11% Carbon) to the sample. Record the weight added. Evenly distribute the spike over the sample and use a glass stir rod to mix the spike with the sample. Do not use that stir rod with any other sample.

Use Talc-free latex gloves from this point on to minimize the risk of acid burns. Add several drops of 1:1 HCL to each sample and stir each sample with its own glass stir rod. Carefully rinse the stir rod and beaker walls with DI water using a fine-tipped squirt bottle. Use only what is needed to bring the entire sample to the bottom of the beaker. ***When adding water to acid use necessary precautions to avoid splashing!*** Samples with high concentrations of inorganic carbon may effervesce to the point of overflowing the beaker, so take care to add the acid in small aliquots and stir vigorously. If the sample "boils over" it must be re-prepared. Continue to add 1:1 HCL in small aliquots until there is no further reaction, taking sample to dryness after each addition of acid in a 105-degree oven.

Dry the treated samples in the oven after each acid/water addition. Do not add more than a total of 200 mL of 1:1 HCL to any sample.

NOTE: *Samples are hydroscopic and will absorb water if they are exposed to air for too long.*

Weigh beaker with residue and record the residue weight measurement. After the sample is thoroughly dry, scrape the sample residue from the beaker and grind to a powder using the pink mortar and pestle. Transfer the ground sample to a clean, dry 40-mL vial reserved for this analysis.

NOTE: *Depending on the nature of the sample, it may be difficult to completely remove the dried residue from the beaker or to grind it to a homogenous powder. Where difficulties are encountered, make a note on the preparation worksheet.*

Analysis

Perform TOC analysis on processed sample material as outlined in section 10.0 of this SOP.

Appendix C: Column Change Procedure

Turn off the helium and oxygen supplies to the instrument.

Dial the left furnace temperature to a reading of 052 (this equates to 520˚C). Wait until the temperature drops below 600˚C to remove the column.

Remove the panel covering the furnace and unscrew the autosampler connection from the top of the column.

Unscrew the fitting at the bottom of the column and remove.

Lift the column up and out of the furnace using high temperature gloves.

CAUTION: The column will still be 500-600˚C. Do not touch the center portion of the column. Place the spent column in the metal can designated for this purpose.

Lay a new quartz column on the bench top, measure and mark off for the following:

- One inch up from the bottom and add a ½ inch plug of quartz wool. Note: pack the quartz wool tightly enough for it to stay in place.
- Pour in 2 ½ inches of copper wire
- Pack another ½ inch quartz wool plug on top of the copper
- Pour in 3 inches of tungsten
- Pack a final ½ inch quartz wool plug on top of the tungsten

Place the new column into the furnace and reconnect the top and bottom fittings. Snug these up, but don’t over tighten.

Replace the panel covering the furnace, dial the furnace temperature back to 102 (this equates to 1020˚C), and turn the helium and oxygen supplies back on.

When the instrument comes up to operating temperature, it is ready to calibrate.

Appendix D: Determination of Black Carbon in Sediment Procedure

1. Obtain a representative subsample of the sediment. Weight 10 grams of sample into a clean pre-tared aluminum drying pan or equivalent.
2. Dry the sample at 105°C for at least 12 hours.
3. Grind the sample using a mortar and pestle.
4. Sieve the sample using a number 35 sieve (500 um).
5. Treat the sample with phosphoric acid. Add acid drop wise until effervescence is no longer observed.
6. Dry the sample at 105°C for 1 hour.
7. Set aside an aliquot of the sample at this stage for direct TOC analysis, reported without correction for the IN623 percent solids. Continue with the sample for Black Carbon.
8. Place the dried sample into a clean crucible and cover the sample.
9. Bake the samples at 375°C in a muffle for 24 hours or until the LCS is +/- 50% of the true value.
10. Allow the samples to cool and transfer approximately 5.0 mg into each of two tin capsules.
11. Transfer the sample (in the tin capsules) to the TOC analyzer for analysis by the Lloyd Kahn Method.
12. The sample is pyrolyzed in an inductive type furnace, where the carbon is converted to carbon dioxide, which is measured using a differential thermal conductivity detector.
13. The results will be reported as mg/Kg Black Carbon.

Note: Black carbon LCS material: NIST Standard Reference Material 1944 New York-New Jersey Waterways Sediment.

References:

Orjan Gustafsson, Thomas D. Bucherli, Zofia Kukulska, Mette Andersson, Claude Largeau, Jean-Noel Rouzaud, Christopher M. Reddy and Timothy I. Eglinton (December 2001) Evaluation of a Protocol for the Quantification of Black Carbon in Sediments, Global Biogeochemical Cycles, Volume 15, pages 881-890.

Orjan Gustafsson, Farnaz Haghseta, Charmaine Chan, John MacFarlane & Philip M. Gschwend (1997) Quantification of the Dilute Sedimentary Soot Phase: Implications for PAH Speciation and Bioavailability, Environmental Science & Technology, Volume 31, pages 203-209.