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March 27, 2019

Ms. Debra Rossi
Remedial Project Manager
United States Environmental Protection Agency
Region III
1650 Arch Street
Philadelphia, Pennsylvania 19103-2029

RE: Army Creek Landfill - New Castle County, Delaware
Revised Work Plan for Additional Investigation

Dear Ms. Rossi:

This work plan has been prepared on behalf of New Castle County (NCC) and the Army Creek Private Settlors (ACPS) in response to the September 28, 2017 letter from the United States Environmental Protection Agency (USEPA) requesting additional investigation at the Army Creek Landfill (ACL; Site [see Figure 1]; USEPA, 2017). More specifically, in the September 28, 2017 letter, the USEPA indicated that additional investigation is needed to:

- Determine the extent of dissolved metals (subsequently agreed on January 11, 2018 to include iron, manganese, cobalt) and 1,2-dichloroethane (1,2-DCA) contamination in groundwater within the Upper Potomac Aquifer (UPA) downgradient of the Army Creek Landfill (ACL) Western Lobe.
- Evaluate the vulnerability of Artesian Water Company's (AWC's) Llangollen Wellfield to releases from the ACL Western Lobe.
- Determine whether the ACL is a source of per- and polyfluoroalkyl substances (PFAS) in groundwater within the UPA.

The scope included in this work plan was developed in consideration of the following:

- Discussions via teleconference on November 30, 2017 between representatives of the USEPA, State of Delaware Department of Natural Resources and Environmental Control (DNREC), NCC and ACPS.
- Meeting on January 11, 2018 with representatives of the USEPA, DNREC, Artesian Water Company (AWC), NCC and ACPS at DNREC's offices.
- Email dated January 19, 2018 and subsequent letter dated January 24, 2018 from the USEPA requesting analysis of major anions and cations in groundwater be added to the scope. (USEPA, 2018a and b)
- Email dated January 31, 2018 from the USEPA in response to email from Ruth Associates Inc. (RAI) dated January 30, 2018. (RAI, 2018a) The USEPA's email

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approved RAI's request for extension of the submittal date to February 14, 2018, and indicated that the USEPA will require the scope include sampling and analysis of water within the ACL gas vents for PFAS. (USEPA, 2018c)

- Work Plan for Additional Investigation (Work Plan) by RAI dated February 14, 2018. (RAI, 2018b)
- Sampling and Analysis Plan (SAP; included as Attachment 4 of the Work Plan) by Golder dated February 2018. (Golder, 2018a)
- Comments on the Work Plan and SAP provided following in the documents as forwarded by the USEPA via email dated April 24, 2018:
    - USEPA Region III and DNREC Comments via letter dated April 24, 2018. (USEPA, 2018d)
    - USEPA Office of Analytical Services and Quality Assurance (OASQA) Comments via Memorandum dated April 13, 2018. (USEPA, 2018d)
    - Ground Water Associates, LLC (GWA) Comments via letter dated March 1, 2018. (GWA, 2018)
- Response to Comments (RTC) document dated June 1, 2018. (Golder and RAI, 2018a)
- Correspondence from USEPA on July 24 and 25, 2018 regarding cross sections.
- Discussions during the July 25, 2018 conference call with USEPA, DNREC, NCC, ACPS, RAI and Golder.
- Submission of ACL cross sections on September 13 and 19, 2018.
- Meeting on September 20, 2018 with representatives of the USEPA, DNREC, Artesian Water Company (AWC), NCC and ACPS at DNREC's offices.
- Email dated October 1, 2018 (Golder, 2018b) summarizing the topics discussed and outcomes of the September 20, 2018 meeting and subsequent October 10, 2018 email from USEPA with clarifying comments. (USEPA, 2018e)
- Submission of Alternate Purging and Sampling Methodologies for Long-Screen Wells (Golder and RAI, 2018b) as requested by USEPA.
- Email dated December 17, 2018 on behalf of NCC and ACPS responding to email dated December 7, 2018 from USEPA requesting updated information regarding well installation and sampling methodologies.
- Email dated December 18, 2018 from USEPA partially approving the Work Plan and extending the deadline for the complete Work Plan. (USEPA, 2018f)
- Email dated February 25, 2019 from USEPA conditionally approving December 11, 2018 Response to USEPA Request for Alternate Purging and Sampling Method for Long-Screen Wells and extending deadline for submission of the Work Plan to March 27, 2019. (USEPA, 2019a)

- Email dated March 20, 2019 from USEPA regarding split sample collection in July 2019. (USEPA, 2019b)
- Email dated March 21, 2019 from USEPA approving revised schedule sent via RAI email for inclusion in the Work Plan. (USEPA, 2019c)

The following provides the background, conceptual site model (CSM), general approach, methodologies, reporting, and schedule.

BACKGROUND

The ACL Site is a former 60-acre sand and gravel quarry that was operated as a landfill between 1960 and 1968 and received 1.9 million cubic yards of municipal and industrial wastes. (USEPA, 1998) The Site is bounded to the west and north by the Norfolk Southern Railroad and to the south and east by Army Creek/Army Pond, which eventually discharges to the Delaware River. Beyond Army Creek, to the east and northeast, there is another Superfund Site, the Delaware Sand & Gravel (DS&G) Site. The DS&G Site is not part of this scope of work; however, information available from investigations performed in connection with the DS&G Site are included within this Work Plan, and groundwater monitoring will be coordinated, to the extent possible, with monitoring being performed for DS&G, to provide synoptic data sets. The location of the ACL and DS&G Sites (Sites) and the existing and proposed monitoring wells in the vicinity of the Sites are shown on Figure 2.

A stability evaluation of manganese, iron and cobalt in the vicinity of the ACL and DS&G Sites was prepared by RAI in response to a recommendation in the USEPA's Fourth Five-Year Review Report for the Site, dated September 8, 2014 (2014 FYR; USEPA, 2014). RAI's draft report dated December 12, 2016 (RAI, 2016) identified statistically significant increases in the concentrations of these metals at Monitoring Well P-4, located downgradient of the Western Lobe of the ACL, between 2006 and 2016. In addition, based on RAI's semi-annual monitoring reports, 1,2-DCA has frequently been detected in groundwater samples collected from Monitoring Well P-4 at concentrations that exceed the maximum concentration limit (MCL). The historical ground-water monitoring results from the wells located downgradient of the Western Lobe are provided as Attachment 1. The scope included in this work plan will assist with qualitative evaluation of the vulnerability of AWC's Llangollen Wellfield to migration of constituents from ACL's Western Lobe.

Manganese concentrations are increasing at AWC's Llangollen Wellfield, and AWC is in the process of designing a treatment system to reduce manganese concentrations to below the secondary drinking water standard (aesthetic standard) of 50 micrograms per liter (ug/l) prior to public distribution. The contaminant plume located between the DS&G Site and the eastern lobe of the ACL that extends downgradient to AWC's Llangollen Wellfield will be mitigated through the remedial actions put forth in the DS&G Record of Decision Amendment No. 2 issued by the USEPA on December 12, 2017.

Based on per- and polyfluoroalkyl substances (PFAS) groundwater monitoring results for samples collected by Golder Associates Inc. from UPA monitoring wells located downgradient of the ACL and DS&G Sites (see Attachment 2), perfluorooctanoic acid (PFOA) and/or perfluorooctanyl sulfonate (PFOS) have been detected above the Health Advisory (HA) of 70 nanograms per liter (ng/l; individually and/or in combination) in monitoring wells along the downgradient edge of the ACL, including Wells P-4, MW-29, and MW-31. Based on a preliminary assessment performed by DNREC in 2015, there are numerous upgradient Sites that may be the source(s) of, or potential contributors to, the PFAS concentrations detected in the UPA downgradient of the Sites.

CONCEPTUAL SITE MODEL

Hydrogeologic Setting

Regional

The Site is located in the up-dip, feather-edge of the Potomac Formation and its stratigraphy is represented by proximal, stream-deposited sands, silts, clays and gravels accumulated in an estuarine, marginal marine basin, with highly variable lateral and vertical distribution of sand, silt, clay and gravel. Figure 3 provides the conceptual stratigraphic column described herein. The Potomac Formation is up to 600 feet thick and is subdivided into Upper Potomac Aquifer (UPA), Middle Potomac Aquifer (MPA) and Lower Potomac Aquifer (LPA). The Columbia Formation rests unconformably upon the upper portion of the Potomac Formation. The Columbia Aquifer is separated from the UPA by the Upper Potomac Confining Unit (UPCU), a regionally thick, competent clay unit. There are occasional subcrop zones where the UPCU has been eroded away and replaced by sands, gravels and cobbles as evidenced by the presence of the Columbia basal gravel unit in areas where paleochannels exist. In the subcrop zones in the vicinity of the Sites, the Columbia Aquifer is in direct contact with the generally fining-upward sequence that is present between the UPCU and the top of the UPA upper sand, referred to as the Transition Zone, or UPCUTZ.

Within the UPA, which is the focus of this study, there is an intermittent clay unit referred to as the Upper Potomac Dividing Clay (UPDC), which separates the UPA into two sand units - the upper sand (US) of the UPA and the lower sand (LS) of the UPA. Based on an oral report from AWC during the January 11, 2018 meeting, the UPDC was not observed during the recent advancement of a borehole for installation of replacement production well AWC-6R. This observation is consistent with descriptions by others that the UPDC can be intermittent.

Site-Specific

The ACL is located within a former sand and gravel pit that "was excavated with a dragline until a 'hard zone' reportedly was encountered. This zone, a local stratigraphic marker unit is generally an iron-cemented conglomerate which marked the base of the Columbia Formation or the top of the underlying Potomac clay. The Potomac clay deposits were probably not removed during the sand and gravel operation, because clay would have

had a deleterious effect on the aggregate quality of the sand, and would have interfered with the operations of the sand plant." (Weston, 1986; pp. 1-13 to 1-14)

Refuse/waste placement began in the early 1960s, after sand and gravel excavation ceased, at the "eastern end and generally proceeded back toward the pit entrance on the west." (Weston, 1986; p, 1-14)

As presented in the Clean Tech FYER, "[i]n the area north of the landfill, the clay layer is completely absent; while immediately south of the landfill the clay layer varies in thickness from 10 feet to over 100 feet (Weston-1986). In the vicinity of the landfill, the top of the Potomac typically is a clay layer that acts to hydraulically isolate the Potomac sands from the overlying Columbia sands and gravels. Where the clay layer is either absent or not well developed, vertical cross-formation groundwater flow may be significant." (Clean Tech, 2000; pp. 43-44)

"The Feasibility Study (FS) (Weston, 1986) determined that a continuous, well developed clay layer exists at the top of the Potomac both in the western portion of the landfill and the area immediately north of the western portion of the landfill. The clay which has relatively low permeability, acts as a barrier to vertical groundwater flow, resulting in lateral groundwater flow within the overlying Columbia formation in the zone of saturated refuse." (Clean Tech, 2000; p. 44) Based on available logs (of varying quality; see Attachment 3) for borings advanced between the Western Lobe and the Llangollen wellfield, the UPA ranges in thickness from approximately 50 to 100 feet thick with intermittent clays (potentially representative of the UPDC).

Current Setting

The Columbia Aquifer groundwater is recharged by precipitation, with the exception of the capped area of the Site which is designed to reduce infiltration. The localized groundwater flow direction within the Columbia Aquifer is generally toward Army Pond and Army Creek, which discharges to the Delaware River to the northeast of the ACL Site. (Clean Tech, 2000)

Based on Weston's FS[1] for the ACL (Weston, 1986; p. 1-16), the water table is within the Columbia Aquifer and the landfilled materials. According to Weston, the western portion "and the area north of the western portion of the landfill generally has a continuous clay floor of relatively low permeability which acts as a barrier to vertical flow. As a result, there exists a relatively thick zone of saturated refuse in this portion of the landfill … Lateral ground-water infiltration to the landfill is occurring on the northwestern margin of the landfill."

These observations are supported by the Clean Tech 2000 FYER[2], which provided groundwater elevations within the Columbia Aquifer, the Potomac Formation and the landfilled materials of the Western Lobe (the report also evaluates the Eastern Lobe, but

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[1] *In 1986, the conditions at the Site were different than today in that the cap had not been installed on the ACL, the NCC groundwater recovery system was in operation near the ACL and AWC's Llangollen wellfield was extracting groundwater at a higher rate than today.*

[2] *In 2000, the conditions at the Site were similar with the exception that the NCC groundwater recovery system was in operation near the eastern lobe of the ACL. The ACL was capped in 1996 and AWC's Llangollen wellfield was extracting groundwater at a generally similar rate as today.*

as that area is not a focus of the additional investigations requested for the ACL Site, that information is not included herein). Data provided from the June 1999 sampling event showed that water levels in the Western Lobe ranged from 16.9 to less than 9.5 feet-mean sea level (ft-msl), with the elevation of Army Creek in the vicinity of the Western Lobe at approximately 4 ft-msl. (Clean Tech, 2000; p. 53) These water-level data suggest that there may be lateral flow from the Columbia Aquifer directly into Army Creek in this area.

Although lithologic data is unavailable for locations immediately beneath the landfill itself, water-level data from the Western Lobe gas vents do not show a hydraulic connection between the water within the landfill and the underlying UPA. Water-level data collected by RAI from 2004 to 2007 (see Attachment 5A; RAI, 2007), during the pilot suspension of the ACL recovery system, show that the water levels measured in the gas vents were relatively steady and higher than the water levels observed in the nearby Potomac wells, which are influenced by regional pumping from the Llangollen Wellfield (see Attachment 5B). Columbia water levels for wells outside the landfill during this same period indicate groundwater flows within the Columbia Aquifer from northwest to southeast (see Attachment 5C), and there is a downward gradient from the Columbia Aquifer to the UPA (see Attachment 5D and 5E, respectively).

Prior to the groundwater withdrawals in this area, the natural groundwater flow in the UPA was toward the Delaware River, located to the east of the Site. The general groundwater flow direction in the UPA is to the south/southeast toward the AWC's Llangollen Wellfield. The presumed dominant direction of groundwater flow downgradient of ACL's Western Lobe is to the south.

The UPA is a confined aquifer except in areas near the subcrop zones where the UPA is semi-confined because the UPCU is absent or more permeable. There is generally a strong downward vertical gradient from the Columbia to the UPA, and between the UPA upper sand to the UPA lower sand, due to extraction, predominantly from the UPA lower sand, by AWC at its Llangollen Wellfield.

Current and Historical Aquifer Use

The UPA is used regionally as a drinking water supply. The groundwater within the UPA upper and lower sand units is withdrawn and treated by AWC at its Llangollen Wellfield. The extraction wells in use by AWC in the Llangollen Wellfield have changed over time, causing shifts in the groundwater flow direction. Prior to the 1980s, wells in the western portion of the wellfield (AWC-2, AWC-6, and AWC-7) were predominantly used. During the 1980s and 1990s, wells across the east-west extent of the wellfield were used (wells AWC-2, AWC-6, AWC-7, AWC-G3 and AWC-K1). Between the late 1990s through 2012, extraction shifted to the wells in the eastern portion of the wellfield (AWC-G3 and AWC-K1) with some contribution from Well AWC-7 in the western portion of the wellfield. The well screens on Wells AWC-K1 and AWC-G3 failed in 2012, and withdrawal shifted to Wells AWC-7 and AWC-2 with a total withdrawal rate ranging from 0 to 1 million-gallons-per-day (MGD) until 2014. Since 2014, AWC has been withdrawing from Wells AWC-2, AWC-6, AWC-7 and AWC-G3R, and average total withdrawal rates have

increased to approximately 2 MGD. Due to a screen failure in 2017, Well AWC-6 was replaced by well AWC-6R and brought online in January 2018.

Historical pumping in the area near the ACL included a groundwater recovery system installed and operated by NCC between 1973 and 2004 to extract contaminated groundwater from the UPA between ACL and AWC's Llangollen Wellfield. Extraction rates in the early years of operation were as high as 1.7 MGD and declined over time to less than 1.0 MGD as the wells, pumps and distribution system became fouled. Between 1992 and 1993, a cap was constructed on the ACL. After installation of the landfill cap, NCC installed and began operating a treatment plant to decrease the iron concentrations in the extracted water prior to discharge to Army Creek, until shut-down of the system occurred in 2004.

Groundwater Management

The UPA is used regionally for drinking water, with AWC's Llangollen Wellfield located approximately 2,100 feet to the southeast of the westernmost portion of the ACL Site. As a result of the aquifer use activities in the area, the Site and surrounding area is considered a Delaware Wellhead Protection Area. Based on discussions with AWC and DNREC, it is anticipated that future use will be similar to current use.

In June 2006, the DNREC Division of Air and Waste Management and the DNREC Division of Water Resources entered into a "Memorandum of Agreement" (MOA) for the "Army Creek & Vicinity, New Castle, Delaware" (DNREC, 2006). The MOA establishes two groundwater management zones (GMZs) to manage releases from ten state-listed sites in the vicinity of Army Creek "and to protect exposure of the public by way of potential groundwater contamination." In general, the GMZs were established to prevent installation of new public or domestic water supply wells without additional layers of State review.

Surface Water

Army Creek is the nearest surface water body to ACL. Army Creek flows along the southwestern corner of the ACL, then flows to the northeast into Army Pond located along the southeastern extent of the ACL. Army Pond/Creek flows to the northeast past the northeastern extent of ACL and continues through a marsh complex prior to flowing to the east into the Delaware River.

"Groundwater originating from the Columbia Aquifer upgradient of the landfill moves through the refuse under the cap[3][3] discharging partially to Army Creek Pond. However, based on ecological studies of Army Creek Pond, there is no present impact on the pond from the landfill, and as stated [above], the recovery well water quality [which was

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[3] *"The historical sampling of the recovery wells, which are the closest to the landfill (and therefore the best locations to evaluate leachate quality), indicate that the water quality has improved since the cap has been constructed and the current groundwater collection and treatment system has been operational." (Clean Tech, 2000) During operation of the recovery wells, the majority of extracted groundwater recharged the UPA and/or Army Creek because the treated groundwater was discharged to Army Pond. Additional information is available in Clean Tech's 2000 FYER.*

discharged to surface water until 2004] at the Site has improved since the cap was constructed." (Clean Tech, 2000)

Surface-water samples collected over the past 14 years, as part of the monitoring program for the ACL Site, consistently demonstrate that the surface water in Army Creek is not adversely impacted by the ACL. Historical surface water monitoring results for monitoring conducted through 2017 (RAI, 2018a) are provided in Attachment 6. There are no known or documented surface-discharge points for the impacted UPA groundwater associated with the ACL since shutdown of the groundwater-recovery system. Based on the strong downward gradients between the Columbia Aquifer and the UPA, discharge of UPA groundwater to the Columbia Aquifer and/or surface water does not occur.

APPROACH AND METHODOLOGIES

The approach and an overview of the methodologies that will be employed for this investigation are outlined below. Detailed descriptions of the field methods, documentation and quality assurance/quality control procedures that will be employed are provided in the Sampling and Analysis Plan (SAP), which is provided as Attachment 4.

Western Lobe Study Area

The following activities will be conducted to evaluate the extent of iron, manganese, cobalt and 1,2-DCA in the UPA downgradient of the ACL Western Lobe and the vulnerability of AWC's Llangollen Wellfield to releases from ACL's Western Lobe:

- The existing UPA monitoring network will be expanded through installation of additional monitoring wells downgradient of the Western Lobe. A total of six new UPA wells will be installed as shown on Figure 2:
    - one new well (P-4L) will be screened in the UPA lower sand adjacent to existing UPA upper sand well P-4, to complete the UPA upper and lower sand well pair at that location;
    - one new well (MW-22NU) will be screened in the UPA upper sand adjacent to existing UPA lower sand well MW-22N, to complete the UPA upper and lower sand well pair at that location; and
    - two new wells (WL-1U and WL-1L) will be installed to form a third pair (one UPA upper sand well and one UPA lower sand well) to the west of the P-4 and P-4/L well pair.
    - two new wells (WL-2U and WL-2L) will be installed to form a fourth pair (one UPA upper sand well and one UPA lower sand well) to the east of the P-4 and P-4/L well pair (between existing wells P-4 and MW-38N).

  Addition of these wells will create an east-west transect of UPA wells (WL-2U and WL-2L in the east, P-4 and P-4L in the center, and WL-1U and WL-1L in the west), and a north-south transect of UPA wells (P-4 and P-4L in the north, MW-22NU and MW-22N in the center, and AWC- 2, AWC-6R and AWC-7 in the south).

- Groundwater from UPA wells in the Western Lobe Study Area (see Figure 4) will be monitored for iron, manganese, and cobalt for four quarters and volatile organic compounds (VOCs) including 1,2-DCA semi-annually. Additionally, major anions and cations will be included in the list of analytes for the semi-annual events. The monitoring program is summarized in Table 1, the well locations and the general Western Lobe Study Area are shown in Figure 2, and monitoring point construction information and sampling information is summarized on Table 2.

Well Installation/Development

Roto-sonic drilling methods will be employed to advance the boreholes for the proposed monitoring wells. Continuous lithologic logging will be used for all proposed wells.

The wells will be constructed of 2-inch diameter, PVC, with 5 to 7-foot-long, 0.010-inch slotted screen, and will be installed through 6-inch diameter, steel isolation casing grouted into the UPCU (competent clay) which divides, where present, the Columbia Aquifer from the UPA. If the UPCU is absent, the isolation casing will be grouted into a lower conductivity portion of the UPCUTZ. The placement of the well screens will be determined in the field, based on: 1) observed volatile organic impact based on organic vapor (i.e., PID) readings (although unlikely) and/or 2) visual evidence of impacts. If there is no evidence of either, then the screen interval will be set across the portion of the UPA (either upper sand or lower sand) with the coarsest materials. Additional information is provided in the SAP (see Attachment 4).

The wells will be developed using swabbing and purging, until clear, sediment-free (low turbidity) water is produced. Pumping rates, observed drawdowns and field parameters will be documented. Additional information is provided in the SAP (see Attachment 4).

In addition, existing wells MW-38N, MW-22N and MW-49N will be logged using natural gamma downhole geophysics to evaluate lithology (sands and gravels) and presence (or absence) of the dividing clay (UPDC) (see SAP Section 4.3.2.4). This information will be used to update the cross sections to be included in the Additional Investigation Report.

Surveying

All new wells will be surveyed for location, ground elevation, top of PVC elevation and top of steel casing elevation. Certain wells for which discrepancies exist between the ACL and DS&G survey data, or which may otherwise be suspect, will be re-surveyed as part of this effort. Additional information is provided in Table 3 and in the SAP (see Attachment 4).

Groundwater Monitoring

Groundwater samples will be collected from the wells located in the Western Lobe Study Area as shown in Figure 2. A summary of the proposed groundwater-monitoring program is provided in Table 1. Samples and water level measurements will be collected during

four quarterly monitoring events, two of which will be synoptic with the ACL semi-annual (April) and annual (October) sampling events.

The primary constituents of interest are iron, manganese and cobalt, and samples will be collected for analysis of both total and dissolved for these constituents and analysis of VOCs including 1,2-DCA during the four quarterly events. The annual (October) and semi-annual (April) sampling events will include sample collection for and analysis of major cations and anions (i.e., calcium, magnesium, sodium, potassium, ammonia, nitrate, nitrite, ferrous iron, bicarbonate, chloride, sulfate, and sulfide) synchronous with the DS&G semi-annual monitoring events. Details of the sample collection, handling and analyses are provided in the SAP (see Attachment 4).

These data will be used to evaluate spatial distribution and temporal trends to evaluate the extent of the impacts from the Western Lobe and to qualitatively evaluate the vulnerability of AWC's Llangollen Wellfield from iron, manganese and/or 1,2-DCA concentrations observed in Well P-4.

Low-flow purging and sampling techniques have been used historically for groundwater monitoring at the ACL and DS&G Sites. Many of the wells at and between these Sites have screens with filter packs longer than the recommended 10-foot-interval for low-flow sampling. The USEPA has requested that volumetric averaging (three-well-volume purging followed by sample collection) be used in place of low-flow techniques. However, recognizing the longer-screen wells were installed to monitor the entire aquifer thickness, but that plume thicknesses can be much less than the aquifer thickness, collection of samples from two different depths within the long-well screen is proposed to aid in assessing whether a portion of the existing well screen intercepts the contaminant flow path, and if so, which portion(s) - the UPA upper sand, lower sand or both.

Based on discussions between the USEPA and the Parties regarding the appropriate purging and sampling techniques for long-screen wells, this revised Work Plan includes use of low-flow purging and sampling techniques with collection of a subset of samples using volumetric averaging (three-well-volume purging followed by sample collection). Approximately two weeks prior to purging and sampling wells screened across both the UPA upper and lower sands, an electromagnetic flow-meter will be used to log the vertical flow within the wells and adjustments to proposed low-flow purging and sampling depths will be made if necessary. SAP Section 4.3.3.3 provides additional information on the procedures, and Table 2 indicates the subset of wells for which the samples will be collected. The rationale for their selection was provided in Response to USEPA Request for Alternate Purging and Sampling Method for Long-Screen Wells dated December 11, 2018 (Golder and RAI, 2018b) and approved by the USEPA via email (USEPA, 2019a) with the addition of a UPA upper/lower sand pair for comparative analysis (USEPA, 2019a; see Section 4.3.3.3 of the SAP).

The sample analytical results from the different methodologies will be tabulated along with their sampling depths to facilitate direct comparison of the information. The data will also be compared using a relative percent difference (RPD) calculation. The results will

be included in the second 2019 semi-annual monitoring event report for the Site. This one-time event activity is being conducted to determine that low-flow purging and sampling is appropriate for long-screen wells at the Site.

PFAS Source Evaluation

PFAS has been detected in the majority of the UPA wells sampled downgradient of the DS&G and ACL Sites. Based on a preliminary assessment performed by DNREC in 2015, there are numerous upgradient sites that may be the source(s) of, or potential contributors to, the PFAS concentrations detected in the UPA downgradient of the Sites.

Evaluation of the ACL as a potential source of or contributor to the PFAS concentrations detected in UPA groundwater will be performed by getting a "snapshot" of the distribution of PFAS in groundwater in the vicinity of the ACL and DS&G Sites. During the first semi-annual sampling event conducted after installation of the new wells, groundwater samples will be collected from the wells shown on Table 1 and Figure 4, which will include UPA wells located upgradient and downgradient of the ACL, and the samples will be analyzed for the list of PFAS included in the SAP (see Attachment 4). This event will be synchronized with a DS&G PFAS sampling event, and the complete sets of data collected for both sites will be included in the evaluation.

At the request of the USEPA, in addition to collection of samples from the UPA, collection of leachate samples and water levels will be attempted from up to ten landfill gas vents (see Table 1 and Figure 4) synchronous with the UPA PFAS monitoring event. An important consideration in the evaluation of PFAS in the gas vent liquids is that the analytical method for PFAS is a drinking water method not intended for use on other matrices such as leachate or wastewater. Therefore, due to the inherent differences between leachate matrices and drinking water matrices, there is the potential for matrix interferences and false positive or false negative results from this analysis, and PFAS analytical results for the aqueous samples collected from gas vents will be considered suspect.

These data along with information about the nature and extent of PFAS migrating from upgradient sources will be incorporated into the qualitative evaluation of other potential sources of the PFAS concentrations detected in UPA groundwater in the vicinity of the Sites.

REPORTING

The results from the first round of monitoring for the Western Lobe Study results will be reported within 60 days receipt of validated data and will include documentation of the new well installation. Subsequent reports will be synchronous with the ACL semi-annual and annual reporting. Reports will include temporal and spatial plots for the data from the Western Lobe Study Area, and groundwater flow evaluation.

The PFAS Source Evaluation will be issued following completion of the DS&G and ACL monitoring events, and will include all data from those events, as well as information gathered about other potential sources located upgradient and in the vicinity of the Sites. PFAS results will be provided to the USEPA and DNREC as an electronic database deliverable (EDD) in the EQUIS format.

A final report summarizing the activities performed and data collected as part of the scope presented in this work plan will be submitted to the USEPA after the completion of the activities outlined in this work plan. The report will include the updated CSM, cross-sections, data summary tables, boring and monitoring well installation logs, and supporting figures.

Progress reports will be submitted to the USEPA monthly beginning with the April 2019 reporting period. The monthly progress reports (MPRs) will summarize the following:

- Physical Work Conducted, Deliverables Submitted, and Meetings/ Teleconferences Held in Reporting Period
- Physical Work, Deliverables and Meetings/Teleconferences Scheduled for Next Month
- Summary of Significant or Unexpected Test Results or Findings
- Status of Access Agreements Obtained for Upcoming Work
- Unresolved Delays that May Affect Upcoming Work
- Proposed Modifications to Work Plans or Schedules
- Upcoming Deliverables (not included above)
- Outstanding Items with USEPA

SCHEDULE

The following is a listing of the anticipated schedule to complete this work as approved by the USEPA on March 21, 2019 (USEPA, 2019c). Please note this these time periods are contingent on USEPA review, response times, and approval and driller availability. Also, monitoring events will be synchronized with the routine ACL and DS&G semi-annual monitoring events.

- Western Lobe Well Installation and Development – April-June 2019
- Quarterly Sampling Events –July 2019; October 2019 (also to include VOCs, anions and cations); January 2019; and April 2020 (also to include VOCs, anions and cations)
- PFAS Sampling Event – October 2019
- First Quarterly Event and Well Installation Report – late September 2019
- PFAS Source Evaluation Report – March 2020
- Subsequent sampling data submitted with ACL's annual (October 2019) and semi-annual (April 2020) monitoring reports in January 2020 and July 2020, respectively.

- Final Report with Updated CSM – July 2020

We hope you find the proposed scope and methodologies clear and satisfactory. If you have any questions or comments, we trust you will contact us so we can provide clarification and revisions as necessary.

Respectfully,

RUTH ASSOCIATES, INC.

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President

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Attachment 1 - Historical Groundwater Monitoring Results, Downgradient of Western Lobe Study Area
Attachment 2 - PFAS Groundwater Monitoring Results Collected by Golder, October 2016 and April 2017

Attachment 3 - Available Boring and Monitoring Well Logs
Attachment 4 - Sampling and Analysis Plan – Revision 1
Attachment 5 - Surface Water, Columbia Aquifer and Vertical Gradient Assessment
- A – Historical Surface Water Quality Monitoring Results, Army Creek
- B – Groundwater Elevations in the Army Creek Landfill Gas Vents and Vicinity Graph
- C – Western Lobe Area – Groundwater Elevations Graph 2004-2007
- D – Columbia Aquifer Groundwater Contour Map – April 2007
- E – Vertical Gradient Assessment Data – 2005-2007

Attachment 6 - Summary of Surface Water Quality Data for Army Creek and Army Pond

REFERENCES

DNREC, 2006. Amended Memorandum of Agreement. Department of Natural Resources and Environmental Control. Army Creek and Vicinity. New Castle, Delaware. June 2006.

Golder, 2018a. Sampling and Analysis Plan. Army Creek Landfill Superfund Site, New Castle, Delaware. February 14, 2018.

Golder, 2018b. Email from Theresa Miller to Debbie Rossi (USEPA) re: Summary of September 20, 2018 ACL Meeting. October 1, 2018.

Golder and RAI, 2018a. Response to Comments on Work Plan for Additional Investigation Army Creek Landfill, New Castle County, Delaware. June 1, 2018.

Golder and RAI, 2018b. Response to USEPA Request for Alternate Purging and Sampling Method for Long-Screen Wells Army Creek Landfill Superfund Site, New Castle County, Delaware. December 11, 2018.

GWA, 2018. Letter to Artesian Resources Corporation re: [Comments on] Army Creek Landfill, Work Plan for Additional Investigation, Ruth Associates, Inc. March 1, 2018.

RAI, 2016. Stability of Iron, Manganese and Cobalt in Groundwater in the Vicinity of Army Creek Landfill, Delaware Sand & Gravel Landfills and the Llangollen Well Field, New Castle County, Delaware, Draft Revision 1. December 12, 2016.

RAI, 2018a. USEPA in response to email from January 30, 2018.

RAI, 2018b. Additional Investigation Work Plan. Army Creek Landfill Superfund Site, New Castle, Delaware. February 14, 2018.

USEPA, 1998. Five-Year Review Report, Army Creek Landfill Superfund Site, New Castle, Delaware. November 25, 1998.

USEPA, 2014. Five-Year Review Report for Army Creek Landfill Superfund Site, New Castle County, Delaware. September 8, 2014.

USEPA, 2017. USEPA letter to ACPS and NCC requesting additional investigation at ACL. September 28, 2017.

USEPA, 2018a. Email from Debbie Rossi (USEPA) to Michael Sherrier (ACL Chairman) and Michael Harris (NCC) regarding addition of cations and anions to semi-annual groundwater monitoring event. January 19, 2018.

USEPA, 2018b. Letter from Rick Wilkin (USEPA) to Debbie Rossi (USEPA) regarding addition of cations and anions to semi-annual groundwater monitoring event. January 24, 2018.

USEPA, 2018c. USEPA email approving request for extension and requesting sampling and analysis of gas vents for PFAS. January 31, 2018.

USEPA, 2018d. Letter from USEPA (Debbie Rossi) with comments on the Additional Investigation Work Plan and SAP. April 24, 2018.

USEPA, 2018e. USEPA email with clarifying comments on Golder email dated October 1, 2018 re: Summary of September 20, 2018 ACL Meeting. October 10, 2018.

USEPA, 2018f. USEPA letter re: Partial Approval of Work Plan and SAP and Approval of Eurofins use of modified PFAS method. December 18, 2018.

USEPA, 2019a. USEPA email re: response to the Alternate Methods Memo. February 25, 2019.

USEPA, 2019b. USEPA email regarding split sample collection during first quarterly event. March 20, 2019.

USEPA, 2019c. USEPA email approving revised schedule from RAI via email dated March 21, 2019. March 21, 2019.

TABLES

TABLE 1
PROPOSED MONITORING PROGRAM
ARMY CREEK LANDFILL, NEW CASTLE, DELAWARE

Monitoring Location	Well Type	PFAS	Western Lobe	Supply Wells	Water Levels
MW-28	Former Recovery	X			X
MW-29	Former Recovery	X			X
MW-31	Former Recovery	X			X
RW-10	Former Recovery	X	X		X
BW-1	Existing Monitoring	X			X
BW-2	Existing Monitoring	X			X
BW-3	Existing Monitoring	X			X
MW-40	Existing Monitoring	X			X
MW-38N	Existing Monitoring				X
P-4	Existing Monitoring	X	X		X
P-4L	Proposed Monitoring	X	X		X
WL-1U	Proposed Monitoring	X	X		X
WL-1L	Proposed Monitoring	X	X		X
WL-2U	Proposed Monitoring	X	X		X
WL-2L	Proposed Monitoring	X	X		X
P-5U	Existing Monitoring				X
P-5L	Existing Monitoring				X
P-6	Existing Monitoring				X
MW-22N	Existing Monitoring	X	X		X
MW-22NU	Proposed Monitoring	X	X		X
MW-26N	Existing Monitoring				X
MW-49N	Existing Monitoring				X
MW-54	Existing Background	X			X
MW-56	Existing Background	X			X
MW-58	Existing Background	X			X
MW-18	Existing Monitoring				X
DGC-10S	Existing Monitoring				X
DGC-10D	Existing Monitoring				X
DGC-11S	Existing Monitoring				X
DGC-11D	Existing Monitoring				X
GV-1	Gas Vent	X			X
GV-7	Gas Vent	X			X
GV-9	Gas Vent	X			X
GV-13	Gas Vent	X			X
GV-14	Gas Vent	X			X
GV-17	Gas Vent	X			X
GV-29	Gas Vent	X			X
GV-46	Gas Vent	X			X
GV-48	Gas Vent	X			X
GV-51	Gas Vent	X			X
AWC-2	Supply Well			X	
AWC-G3R	Supply Well			X	
AWC-6R	Supply Well			X	
AWC-7	Supply Well			X	

3/27/2019

Notes:

X - Groundwater samples will be analyzed for PFAS suite, consistent with the PFAS suite for DS&G, plus field parameters.
Samples from gas vents will be analyzed for PFAS suite only.

X - Quarterly analytical parameters will include VOCs, total and dissolved iron, total and dissolved manganese, total and dissolved cobalt, and field parameters. The semi-annual events (April and October) will also include and cations and anions as follows: calcium, magnesium, potassium, sodium, ammonia, nitrate, nitrite, sulfate, sulfide, chloride, and bicarbonate.

X - Supply wells will be sampled by AWC monthly for iron and manganese analyses, and quarterly for cobalt.
Addition of other parameters is under consideration by AWC. Only wells that are operating will be sampled during each event.

X - A complete round of water levels will be measured synoptically at all wells, within 48 hours of the completion of the sampling event.

(1) - PFAS monitoring event will be conducted synoptically during the first DS&G event performed after the new wells are installed.

(2) - Western Lobe Study will be conducted quarterly for four quarters, two of which will be done at same time as annual/semi-annual events.

(3) - Field Indicator Parameters include temperature, specific conductance, pH, oxidation-reduction potential, dissolved oxygen and turbidity.

Table 2
Monitoring Point Construction Information
Army Creek Landfill Superfund Site
New Castle County, Delaware

Monitoring Point ID	Drilled Depth	Constructed Use	Inside Diameter (in)	Construction Material	Sounded Depth (ft-btoc)	TOC Elevation (ft-msl)	Screened Interval (ft-bgs)	Screen Length (ft)	Filter Pack Interval (ft-bgs)	Filter Pack Material	Backfill Interval[2] (ft-bgs)	Backfill Material	Filter Pack Length (ft)	Screened Unit	Surface Completion	Purging and Sampling Method	Proposed Sampling Depth (ft-btoc)	Secondary Method for Comparison	Previous Sampling Depth (ft-bgs)
MW-28	140	Former Extraction Well	6	Stainless Steel	111.6	20.37	43 - 120	77	No Record	No Record	120-130	No Record	≥77	UPA - Upper and Lower Sand	Standpipe	Submersible - low flow	50 and 90	yes - 3x purge	50
MW-29	130	Former Extraction Well	6	Stainless Steel	110.5	17.38	34 - 113	79	No Record	No Record	126-113	No Record	≥79	UPA - Upper and Lower Sand	Standpipe	Submersible - low flow	39 and 85	yes - 3x purge	39
MW-31	120	Former Extraction Well	6	Steel-PVC	112.1	13.77	59 - 116	57	No Record	No Record	116-120	No Record	≥57	UPA - Upper and Lower Sand	Standpipe	Submersible - low flow	75 and 95	yes - 3x purge	75
RW-10	102.5	Former Extraction Well	10	PVC	104	8.67	77 - 102	25	Unknown to 102.5	#2 Gravel	Not Applicable	Not Applicable	≥25.5	UPA - Upper Sand	Standpipe	Submersible - low flow	90	none	90
BW-1	126.5	Monitoring Well	4	PVC	132.9*	30.32*	116.2 - 136.2*	20	111.2-136.7*	#2 Morie Sand	Not Applicable	Not Applicable	25.5	UPA - Lower Sand	Standpipe	Submersible - low flow	126	none	126
BW-2	125	Monitoring Well	4	PVC	142.9*	33.68*	123 - 143*	20	118-143*	#2 Morie Sand	143-144*	Not Specified	≤26	UPA - Lower Sand	Standpipe	Submersible - low flow	133	none	133
BW-3	135	Monitoring Well	4	PVC	125	7.80	50 - 135	85	47-135	#2 Morie Sand	135-137	Not Specified	≤90	UPA - Upper and Lower Sand	Standpipe	Submersible - low flow	55 and 92	yes - 3x purge	92
MW-40	152	Monitoring Well	4	PVC	142.1	36.32	110 - 140	30	No Record	No Record	140-152	No Record	≥30	UPA - Lower Sand	Standpipe	Submersible - low flow	125	none	125
MW-38N	132	Monitoring Well	4	PVC	131.2	35.55	72 - 132	60	69-132	#2 Morie Sand	132-136	Not Specified	≤67	UPA - Upper and Lower Sand	Flush mount	NA - water levels only	NA	NA	NA
P-4	137	Monitoring Well	2	PVC	124.9	47.89	115 - 125	10	108-135	Sand	125-135	Sand	27	UPA - Upper Sand	Flush mount	Submersible - low flow	120	yes - 3x purge	120
P-4L	DNE	Monitoring Well (proposed)	2 (proposed)	PVC (proposed)	TBD	TBD	TBD	≤ 8 (proposed)	TBD	#2 Sand (proposed)	TBD	Grout (proposed)	≤10 (proposed)	UPA - Lower Sand (proposed)	Flush mount (proposed)	Submersible - low flow	TBD	NA	NA
WL-1U	DNE	Monitoring Well (proposed)	2 (proposed)	PVC (proposed)	TBD	TBD	TBD	≤ 8 (proposed)	TBD	#2 Sand (proposed)	TBD	Grout (proposed)	≤10 (proposed)	UPA - Upper Sand (proposed)	Standpipe (proposed)	Submersible - low flow	TBD	yes - 3x purge	NA
WL-1L	DNE	Monitoring Well (proposed)	2 (proposed)	PVC (proposed)	TBD	TBD	TBD	≤ 8 (proposed)	TBD	#2 Sand (proposed)	TBD	Grout (proposed)	≤10 (proposed)	UPA - Lower Sand (proposed)	Standpipe (proposed)	Submersible - low flow	TBD	yes - 3x purge	NA
WL-2U	DNE	Monitoring Well (proposed)	2 (proposed)	PVC (proposed)	TBD	TBD	TBD	≤ 8 (proposed)	TBD	#2 Sand (proposed)	TBD	Grout (proposed)	≤10 (proposed)	UPA - Upper Sand (proposed)	Standpipe (proposed)	Submersible - low flow	TBD	NA	NA
WL-2L	DNE	Monitoring Well (proposed)	2 (proposed)	PVC (proposed)	TBD	TBD	TBD	≤ 8 (proposed)	TBD	#2 Sand (proposed)	TBD	Grout (proposed)	≤10 (proposed)	UPA - Lower Sand (proposed)	Standpipe (proposed)	Submersible - low flow	TBD	NA	NA
P-5U	132	Monitoring Well	4	PVC	82.8	15.30	70 - 80	10	65-90	NR	90-132	NR	≥15	UPA - Upper Sand	Standpipe	NA - water levels only	NA	NA	NA
P-5L	180	Monitoring Well	4	PVC	138	14.90	126 - 136	10	104-126	NR	126-136	NR	≥22	UPA - Lower Sand	Standpipe	NA - water levels only	NA	NA	NA
P-6	117	Monitoring Well	4	PVC	110.5	43.06	100 - 110	10	87-120	NR	110-120	NR	33	UPA - Upper Sand	Flush mount	NA - water levels only	NA	NA	NA
MW-22N	159	Monitoring Well	4	PVC	159.18	51.58	139 - 159	20	134-159	#2 Morie Sand	Not Applicable	Not Applicable	25	UPA - Lower Sand	Flush mount	Submersible - low flow	149	yes - 3x purge	149
MW-22NU	DNE	Monitoring Well (proposed)	2 (proposed)	PVC (proposed)	TBD	TBD	TBD	≤ 8 (proposed)	TBD	#2 Sand (proposed)	TBD	Grout (proposed)	≤10 (proposed)	UPA - Upper Sand (proposed)	Flush mount (proposed)	Submersible - low flow	TBD	NA	NA
MW-26N	168	Monitoring Well	4	PVC	167.41	36.76	108 - 168	60	105-168	#2 Morie Sand	Not Applicable	Not Applicable	63	UPA - Upper and Lower Sand	Standpipe	NA - water levels only	NA	NA	NA
MW-49N	158	Monitoring Well	4	PVC	156.97	51.41	113 - 158	60	109-158	#2 Morie Sand	Not Applicable	Not Applicable	49	UPA - Upper and Lower Sand	Flush mount	NA - water levels only	NA	NA	NA
MW-54	131	Monitoring Well	4 (assumed)	PVC (assumed)	unknown	26.33	40 - 50	10	No Record	No Record	No Record	No Record	No Record	UPA - Upper Sand	Standpipe	Submersible - low flow	TBD - no log	none	NA
MW-56	105	Monitoring Well	4	PVC	unknown	23.21	75 - 100	25	No Record	No Record	100-105	No Record	≥25	UPA - Upper Sand	Standpipe	Submersible - low flow	85	none	NA
MW-58	118	Monitoring Well	4	PVC	unknown	10.62	65 - 110	35	No Record	No Record	110-118	No Record	≥35	UPA - Upper Sand	Standpipe	Submersible - low flow	75 and 95	yes - 3x purge	NA
MW-18	145	Monitoring Well	1	PVC	90.5	6.97	80 - 90	10	No Record	No Record	90-145	No Record	≥10	UPA - Upper Sand	Standpipe	NA - water levels only	NA	NA	NA
DGC-10S	115	Monitoring Well	4	PVC	115.4	41.92	93 - 113	20	91-113	#1 Morie Sand	113-115	Morie #1 Sand	24	UPA - Upper Sand	Standpipe	NA - water levels only	NA	NA	NA
DGC-10D	172	Monitoring Well	4	PVC	138.4	41.77	128 - 138	10	126-138	#1 Morie Sand	138-172	#1 Morie Sand/Sand fill and cuttings	46	UPA - Lower Sand	Standpipe	NA - water levels only	NA	NA	NA
DGC-11S	82	Monitoring Well	4	PVC	79.9	38.54	70 - 80	10	68-80	#1 Morie Sand	80-82	Morie #1 Sand	14	UPA - Upper Sand	Standpipe	NA - water levels only	NA	NA	NA
DGC-11D	182	Monitoring Well	4	PVC	115	38.93	105 - 115	10	103-115	#1 Morie Sand	115-182	#1 Morie Sand/Sand fill and cuttings	79	UPA - Upper Sand	Standpipe	NA - water levels only	NA	NA	NA
GV-1	unk	Former Gas Vent	4	PVC	23.59	30.96	unknown	unknown	unknown	unknown	unknown	unknown	unknown	Landfilled material	Standpipe	Bailer - 3x purge	NA	NA	NA
GV-7	unk	Former Gas Vent	4	PVC	27.3	35.13	unknown	unknown	unknown	unknown	unknown	unknown	unknown	Landfilled material	Standpipe	Bailer - 3x purge	NA	NA	NA
GV-9	unk	Former Gas Vent	4	PVC	19.94	33.83	unknown	unknown	unknown	unknown	unknown	unknown	unknown	Landfilled material	Standpipe	Bailer - 3x purge	NA	NA	NA
GV-13	unk	Former Gas Vent	4	PVC	22.3	37.64	unknown	unknown	unknown	unknown	unknown	unknown	unknown	Landfilled material	Standpipe	Bailer - 3x purge	NA	NA	NA
GV-14	unk	Former Gas Vent	4	PVC	25.77	39.77	unknown	unknown	unknown	unknown	unknown	unknown	unknown	Landfilled material	Standpipe	Bailer - 3x purge	NA	NA	NA
GV-17	unk	Former Gas Vent	4	PVC	23.8	38.61	unknown	unknown	unknown	unknown	unknown	unknown	unknown	Landfilled material	Standpipe	Bailer - 3x purge	NA	NA	NA
GV-29	unk	Former Gas Vent	4	PVC	24.65	36.22	unknown	unknown	unknown	unknown	unknown	unknown	unknown	Landfilled material	Standpipe	Bailer - 3x purge	NA	NA	NA
GV-46	unk	Former Gas Vent	4	PVC	25.77	38.27	unknown	unknown	unknown	unknown	unknown	unknown	unknown	Landfilled material	Standpipe	Bailer - 3x purge	NA	NA	NA
GV-48	unk	Former Gas Vent	4	PVC	31.9	38.93	unknown	unknown	unknown	unknown	unknown	unknown	unknown	Landfilled material	Standpipe	Bailer - 3x purge	NA	NA	NA
GV-51	unk	Former Gas Vent	4	PVC	29	36.70	unknown	unknown	unknown	unknown	unknown	unknown	unknown	Landfilled material	Standpipe	Bailer - 3x purge	NA	NA	NA

Notes:

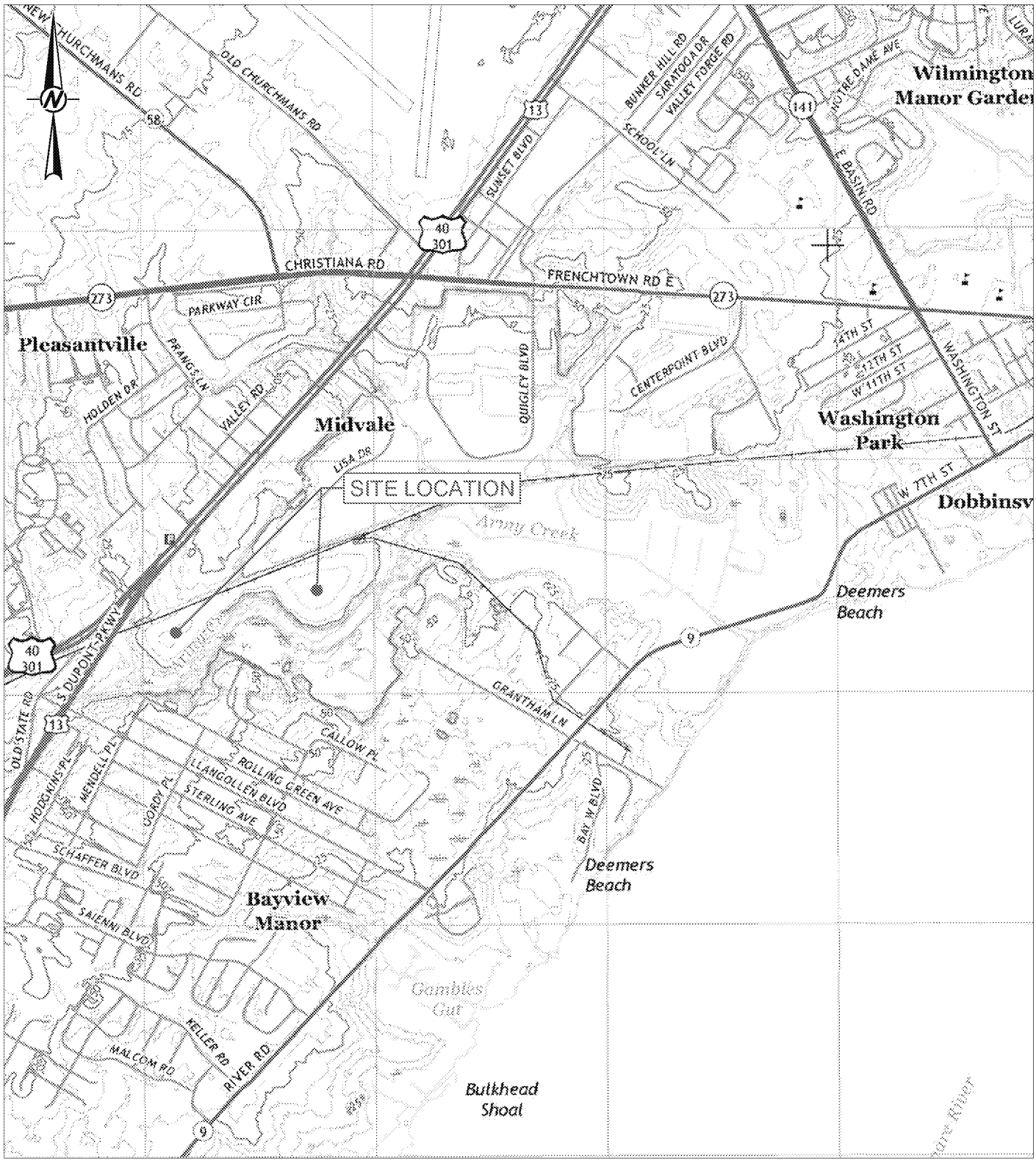
1.) MW-22N, MW-26N and MW-49N sounded depth measurements collected on September 14, 2012 by Golder Associates; GV sounded depth measurements collected on September 27, 2004 by Rizzo Associates; all other sounded depth measurements collected February 29 through March 2, 2016 by Ruth Associates.
2.) ft-bgs = feet below ground surface
3.) ft-btoc = feet below top of casing
4.) ft-msl = feet mean sea level
5.) in = inches
6.) NA = not applicable
7.) PVC = polyvinyl chloride
8.) TBD = to be betermined
9.) TOC = top of casing
10.) UPA = Upper Potomac Aquifer
11.) "No Record" indicates monitoring well construction log was not found or was not created at the time of well installation.
12.) "Not Specified" indicates monitoring well construction log did not include the indicated information.
13.) unk = unknown
14.) * indicates different from monitoring well construction log due to extention of well by New Castle County in Reforestation Area

Table 3
Monitoring Point Elevation Discrepancies
Army Creek Landfill Superfund Site
New Castle County, Delaware

Monitoring Point ID	Casing Reference Point	Top of Casing (TOC) Elevation used by Golder 1929 NGVD		Top of Casing (TOC) Elevation used by RAI Datum Unknown		Difference in TOC Elevation (feet; Golder-RAI)	Observations / Recommendations
		Elevation (ft-msl)	Source of Information	Elevation (ft-msl)	Source of Information		
MW-28	Steel	using RAI info	NA	20.37	2001 TetraTech Rpt	NA	**Datum Unknown, Resurvey using 1929 NGVD**
MW-29	Steel	using RAI info	NA	17.38	2001 TetraTech Rpt	NA	**Datum Unknown, Resurvey using 1929 NGVD**
MW-31	Steel	13.77	2012 TWT Survey	13.45	unknown	0.32	Use TWT Survey Data
RW-10	Steel	using RAI info	NA	8.67	2001 TetraTech	NA	**Datum Unknown, Resurvey using 1929 NGVD**
BW-1	PVC	30.32	2015 TWT Survey[1]	29.71	unknown	0.61	**Resurvey using 1929 NGVD**
BW-2	PVC	33.68	2015 TWT Survey[1]	33.09	unknown	0.59	**Resurvey using 1929 NGVD**
BW-3	PVC	using RAI info	NA	7.00	2001 TetraTech Rpt	NA	**Datum Unknown, Resurvey using 1929 NGVD**
MW-40	PVC	36.32	2015 TWT Survey	36.05	unknown	0.27	Use TWT Survey Data
P-4	PVC	using RAI info	NA	47.89	2002 TetraTech Rpt	NA	**Datum Unknown, Resurvey using 1929 NGVD**
P-5U	PVC	15.30	2013 TWT Survey	14.71	unknown	0.59	Possible datum difference, use TWT Survey Data
P-5L	PVC	14.91	2013 TWT Survey	14.34	unknown	0.57	Possible datum difference, use TWT Survey Data
P-6	PVC	43.06	2013 TWT Survey	42.39	unknown	0.67	Possible datum difference, use TWT Survey Data
MW-22N	PVC	51.68	2012 TWT Survey	50.71	unknown	0.97	Use TWT Survey Data
MW-26N	PVC	36.76	2012 TWT Survey	35.41	unknown	1.35	Use TWT Survey Data
MW-38N	PVC	35.55	2015 TWT Survey	35.05	unknown	0.50	Use TWT Survey Data
MW-49N	PVC	51.41	2012 TWT Survey	50.96	unknown	0.45	Use TWT Survey Data
MW-54	PVC	using RAI info	NA	24.95	unknown	NA	**Datum Unknown, Resurvey using 1929 NGVD**
MW-56	PVC	using RAI info	NA	22.03	unknown	NA	**Datum Unknown, Resurvey using 1929 NGVD**
MW-58	PVC	using RAI info	NA	11.14	unknown	NA	**Datum Unknown, Resurvey using 1929 NGVD**
MW-18	Steel	6.97	2012 TWT Survey	7.40	unknown	-0.43	Use TWT Survey Data
DGC-10S	PVC	41.92	2012 TWT Survey	40.94	unknown	0.98	Use TWT Survey Data
DGC-10D	PVC	41.77	2012 TWT Survey	42.11	unknown	-0.34	Use TWT Survey Data
DGC-11S	PVC	38.54	2012 TWT Survey	37.80	unknown	0.74	Possible datum difference, use TWT Survey Data
DGC-11D	PVC	38.93	2012 TWT Survey	38.16	unknown	0.77	Possible datum difference, use TWT Survey Data

Notes
1. Well casing have been extended since this time and there may be survey discrepancies.
2. Golder estimates that difference in datum from 1929 NGVD to 1988 NAVD would be about 0.65 feet +/- 0.1 feet for this area.
3. TWT = Taylor Wiseman Taylor (licensed surveyor)
4. ft-msl = feet-mean sea level
5. NA = not applicable
6. RAI = Ruth Associates Inc.
7. PVC = polyvinyl chloride

FIGURES



REFERENCE(S)

1. BASE MAP TAKEN FROM USGS 7.5 MINUTE QUADRANGLE OF WILMINGTON SOUTH, DELAWARE, DATED 2016.

0 1000 2000
1" = 2000' FEET

CLIENT
ARMY CREEK LANDFILL SUPERFUND SITE
NEW CASTLE, DELAWARE

PROJECT
ADDITIONAL INVESTIGATION WORK PLAN

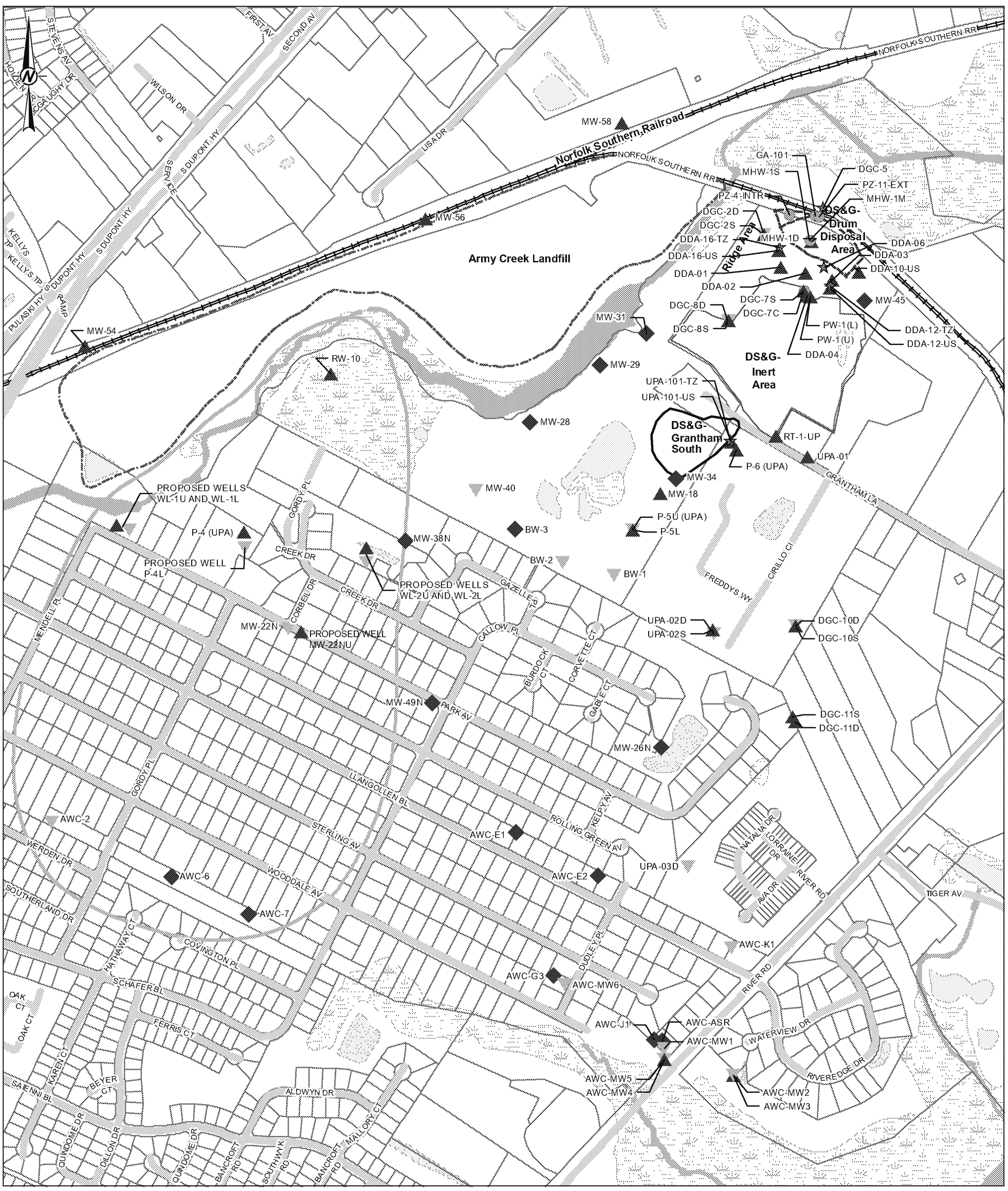
CONSULTANT
GOLDER

YYYY-MM-DD	2019-03-25
DESIGNED	BAR
PREPARED	AM
REVIEWED	BAR
APPROVED	TAM

TITLE
SITE LOCATION MAP

PROJECT NO	CONTROL	REV.	FIGURE
1899295	0001-005	0	1

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI A



LEGEND

- WELL SCREENED IN UPCU TRANSITION ZONE
- WELL SCREENED IN UPA UPPER SAND
- WELL SCREENED IN UPA LOWER SAND
- WELL SCREENED ACROSS UPA UPPER SAND AND LOWER SAND
- WELL SCREENED IN COLUMBIA AQUIFER
- WESTERN LOBE STUDY BOUNDARY

REFERENCE(S)

1. BASE DATA FROM NEW CASTLE COUNTY DELAWARE, DEPARTMENT OF LAND USE, "EPARCEL VIEW MAP" WEB SITE GIS DATA DOWNLOAD. DATA ACQUIRED 01/18/2012.

0 600 1,200
1" = 600 feet Feet

CLIENT
ARMY CREEK LANDFILL SUPERFUND SITE
NEW CASTLE, DELAWARE

PROJECT
ADDITIONAL INVESTIGATION WORK PLAN

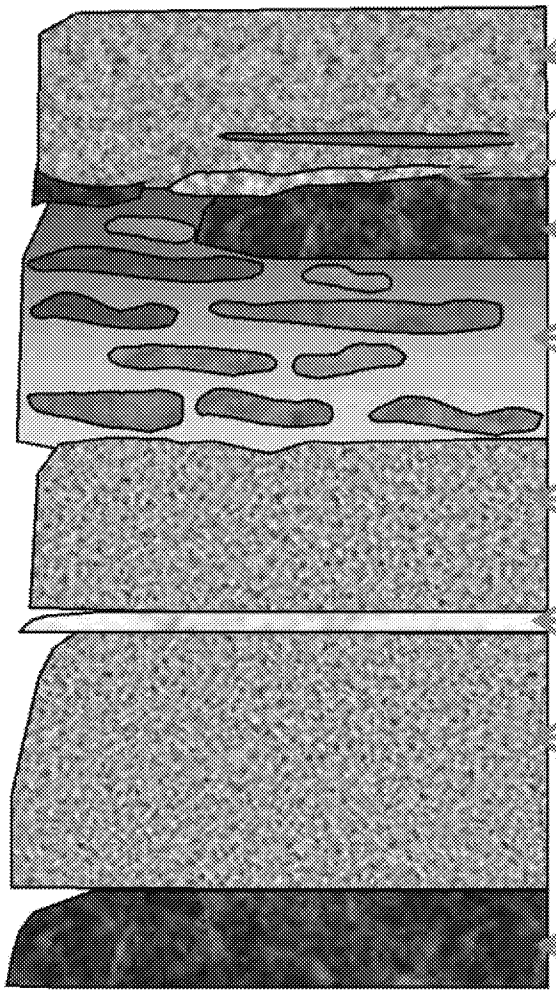
CONSULTANT
GOLDER

YYYY-MM-DD	2019-03-25
DESIGNED	BAR
PREPARED	AM
REVIEWED	BAR
APPROVED	TAM

TITLE
EXISTING AND PROPOSED MONITORING NETWORK FOR ACL WESTERN LOBE INVESTIGATION

PROJECT NO.	CONTROL	REV.	FIGURE
1899295	0001-004	0	2

Conceptual Site Model Lithologic Diagram



Columbia Sand – brown, tan, orange sandy aquifer unit.

Columbia Clay (not always present) – brown, tan clay unit located within the Columbia Sand.

Basal Gravel (not always present) – gravel and cobble unit with coarse sand.

Upper Potomac Confining Unit (UPCU) (not always present) – hard, competent, dry, mottled red-orange-yellow-white clay unit. Eroded in some areas by basal gravel (paleochannel).

UPCU Transition Zone (UPCUTZ) (not always present) - interbedded silt, clay, and sand, but generally fining upward sequence.

Upper Potomac Aquifer (UPA) – Upper Sand – generally a fine to medium sand unit in the Site area.

Upper Potomac Dividing Clay (UPDC) – Typically, a mottled clay unit, generally present in the Site area, but can be thin or interbedded with sand.

Upper Potomac Aquifer (UPA) – Lower Sand – generally a fine to coarse sand unit greater than 10 feet thick in the Site area.

Middle Potomac Confining Unit (MPCU) - competent, grey or mottled red-orange-yellow-white clay unit.

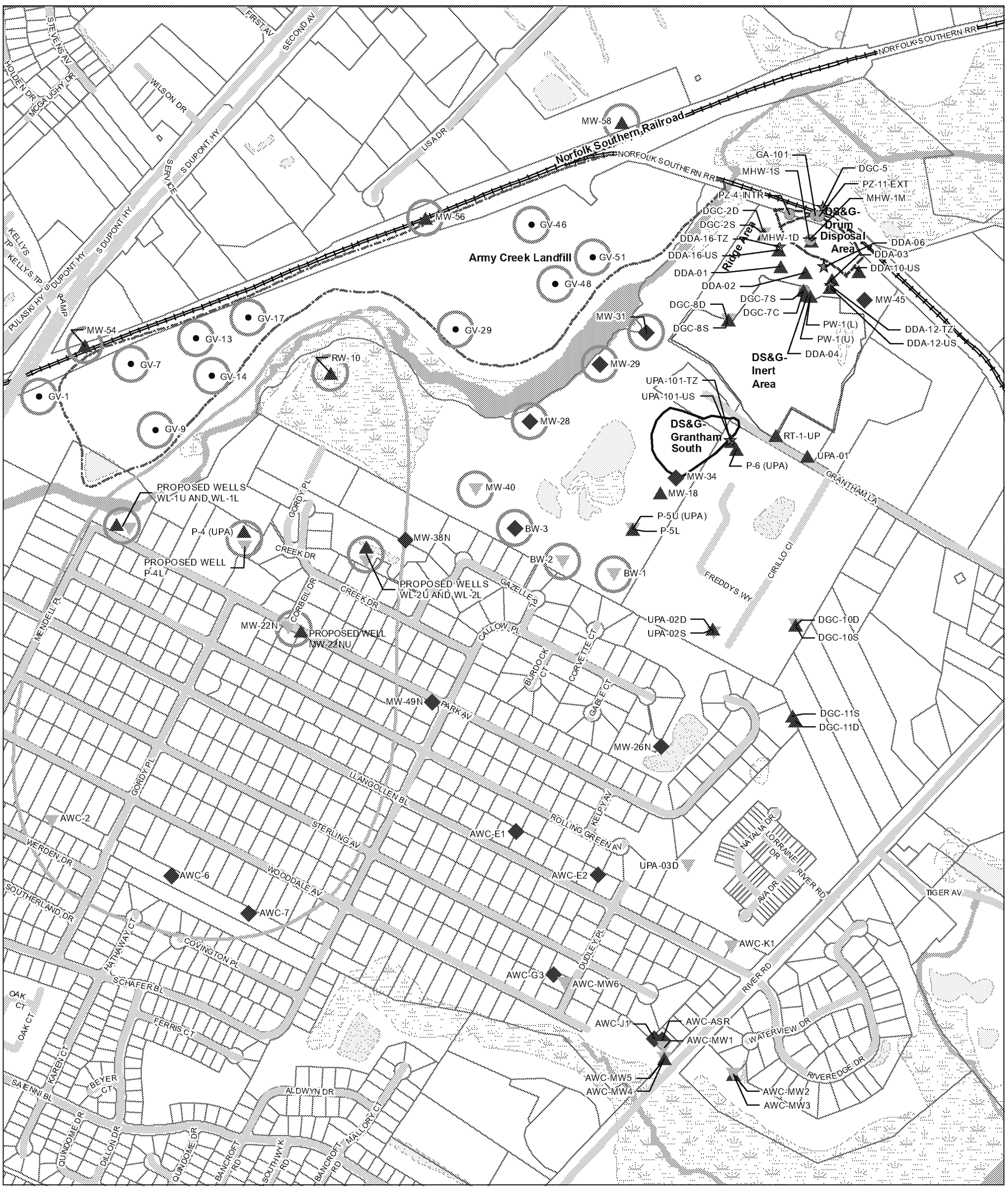
NOT TO SCALE

CLIENT ARMY CREEK LANDFILL SUPERFUND SITE NEW CASTLE, DELAWARE	PROJECT ADDITIONAL INVESTIGATION WORK PLAN
CONSULTANT GOLDER	TITLE **CONCEPTUAL STRATIGRAPHIC COLUMN**

YYYY-MM-DD	2019-03-25
DESIGNED	BAR
PREPARED	AM
REVIEWED	BAR
APPROVED	TAM

PROJECT NO	CONTROL	REV.	FIGURE
1899295	0001-006	0	3

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI A



LEGEND

- GV
- WELL SCREENED IN UPCU TRANSITION ZONE
- WELL SCREENED IN UPA UPPER SAND
- WELL SCREENED IN UPA LOWER SAND
- WELL SCREENED ACROSS UPA UPPER SAND AND LOWER SAND
- WELL SCREENED IN COLUMBIA AQUIFER
- WESTERN LOBE STUDY BOUNDARY
- PFAS SAMPLING LOCATION

REFERENCE(S)

1. BASE DATA FROM NEW CASTLE COUNTY DELAWARE, DEPARTMENT OF LAND USE, "EPARCEL VIEW MAP" WEB SITE GIS DATA DOWNLOAD. DATA ACQUIRED 01/18/2012.

0 600 1,200
1" = 600 feet Feet

CLIENT
ARMY CREEK LANDFILL SUPERFUND SITE
NEW CASTLE, DELAWARE

PROJECT
ADDITIONAL INVESTIGATION WORK PLAN

CONSULTANT
GOLDER

YYYY-MM-DD	2019-03-25
DESIGNED	BAR
PREPARED	AM
REVIEWED	BAR
APPROVED	TAM

TITLE
PROPOSED PFAS GROUNDWATER SAMPLING LOCATIONS

PROJECT NO.	CONTROL	REV.	FIGURE
1899295	0001-007	0	4

ATTACHMENT 1

HISTORICAL GROUNDWATER MONITORING RESULTS
DOWNGRADIENT OF WESTERN LOBE STUDY AREA

Attachment Table 1-1

Historical Summary of Groundwater Quality Data Collected by New Castle County for the Vicinity of the Army Creek and Delaware Sand & Gravel Landfills

Parameter	RW-10																		
	6/93	6/94	6/95	6/96	6/97	6/98	6/99	7/00	10/00	12/00	4/01	7/01	10/01	1/02	4/02	7/02	10/02	1/03	4/03
***Non-Halogenated VOCs* (µg/l)**																			
Benzene	5 U	5 U	0.2 J	0.2 J	0.5 U	0.2 J	0.1 J	0.5 U	--	--	0.2 J	0.2 J	--	--	--	0.5 U	--	--	--
Toluene	--	--	--	--	--	--	--	--	--	--	0.2 B	0.5 J	--	--	--	--	--	--	--
Ethylbenzene	--	--	--	--	--	--	--	--	--	--	1 U	1 U	--	--	--	--	--	--	--
Xylene (total)	--	--	--	--	--	--	--	--	--	--	1 U	1 U	--	--	--	--	--	--	--
2-Butanone	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Acetone	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Carbon Disulfide	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cyclohexane	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Isopropylbenzene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Methy-tert-butyl ether	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Methylcyclohexane	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4-Methyl-2-pentanone	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
***Halogenated VOCs* (µg/l)**																			
Bromoform	--	--	--	--	--	--	--	--	--	--	1 U	1 U	--	--	--	--	--	--	--
Bromodichloromethane	--	--	--	--	--	--	--	--	--	--	1 U	1 U	--	--	--	--	--	--	--
Carbon Tetrachloride	5 U	5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	--	--	1 U	0.5 U	--	--	--	0.5 U	--	--	--
Chlorobenzene	--	--	--	--	--	--	--	--	--	--	0.4 J	0.3 J	--	--	--	--	--	--	--
Chloroform	--	--	--	--	--	--	--	--	--	--	1 U	0.2 J	--	--	--	--	--	--	--
Chloromethane	--	--	--	--	--	--	--	--	--	--	1 U	1 U	--	--	--	--	--	--	--
Dibromochloromethane	--	--	--	--	--	--	--	--	--	--	1 U	1 U	--	--	--	--	--	--	--
1,2-Dichloroethane	55	28	18	19	0.5 U	3.8	3.8	5.1	--	--	4	3	--	--	--	6	--	--	--
1,3 Chlorobenzene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1,1-Dichloroethane	--	--	--	--	--	--	--	--	--	--	1 U	1 U	--	--	--	--	--	--	--
cis-1,2-Dichloroethene	--	--	--	--	--	--	--	--	--	--	1 U	1 U	--	--	--	--	--	--	--
trans-1,2-Dichloroethene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1,1-Dichloroethene	5 U	5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	--	--	1 U	1 U	--	--	--	0.5 U	--	--	--
1,2-Dichloroethene (total)	--	--	--	--	--	--	--	--	--	--	2 U	2 U	--	--	--	--	--	--	--
1,2-Dichlorobenzene	--	--	--	--	--	--	--	--	--	--	1 U	1 U	--	--	--	--	--	--	--
1,3-Dichlorobenzene	--	--	--	--	--	--	--	--	--	--	1 U	1 U	--	--	--	--	--	--	--
1,4-Dichlorobenzene	5 U		0.5 U	0.2 J	0.5 U	0.1 J	0.1 J	0.5 U	--	--	0.1 B	0.2 J	--	--	--	0.5 U	--	--	--
Chloroethane	--	--	--	--	--	--	--	--	--	--	1 U	0.1 UJ	--	--	--	--	--	--	--
Tetrachloroethene	--	--	--	--	--	--	--	--	--	--	7	6	--	--	--	--	--	--	--
1,1,1-Trichloroethane	5 U	5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.1 J	0.5 U	--	--	1 U	1 U	--	--	--	0.5 U	--	--	--
Trichloroethene	5 U	5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.1 J	0.5 U	--	--	1 U	1 U	--	--	--	0.5 U	--	--	--
Vinyl Chloride	5 U	5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	--	--	1 U	1 U	--	--	--	0.5 U	--	--	--
1,2,4-Trichlorobenzene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
cis-1,3-Dichloropropene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Methylene Chloride	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Trichlorofluoromethane	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
***Semi-Volatiles* (µg/l)**																			
Bis(2-chloroethyl)Ether	--	--	--	--	--	--	--	0.0241 J	0.024 U	0.03 U	0.02 J	0.024 U	0.025 U	0.026 U	0.018	0.04 U	0.05 U	0.02 J	0.05 U
Bis(2-ethylhexyl)phthalate	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
2,2'-oxybis (1-Chloropropane)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
2,4-Dimethylphenol	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
2-Methylnaphthalene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
2-Methylphenol	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4-Methylphenol	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Acetophenone	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Caprolactam	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Diethylphthalate	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
N-Nitrosodiphenylamine	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Naphthalene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Phenol	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Inorganics (mg/l)																			
Dissolved Manganese	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dissolved Iron	1.15	0.60	0.25	0.29	1.90	0.40	5.40	0.11	--	--	0.138 B	0.141	--	--	--	0.23	--	--	0.296
Biological Oxygen Demand (mg/l)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Field Parameters																			
Temperature (Degrees Celcius)	--	--	--	--	--	--	--	--	--	--	--	--	--	12.39	--	--	--	--	14.2
Conductivity (µs/cm)	--	--	--	--	--	--	--	--	--	--	--	--	--	180	--	--	--	--	185
pH (standard units)	5.80	5.51	5.53	5.96	6.63	5.88	5.92	5.84	--	--	--	5.75	--	6.52	--	6.26	--	--	5.47
Dissolved Oxygen (mg/l)	--	--	--	--	--	--	--	--	--	10.04	--	--	--	--	--	--	--	--	2.27
ORP (mV)	--	--	--	--	--	--	--	--	--	--	--	--	--	251.0	--	--	--	--	121.1
Water-Level Elevation (ft, MSL)	--	--	--	--	--	--	--	--	--	-56.54	-59.04	-60.61	-61.94	-60.01	-30.33	-30.46	-31.13	-29.98	-26.93

-- Not analyzed or data not available to RAI as of November 29, 2016
U - Analyte was not detected above the reporting limit
J - Estimated concentration.
K - Analyte present, reported value may be biased high.
L - Analyte present, reported value may be biased low.
UL - Not detected, quantitation limit is probably higher

D - Sample diluted in the lab for analysis.
NP - Well not pumping
P - Discrepency in GC analysis. Lower value reported
B - Analyte Detected in Method Blank

Attachment Table 1-1 (continued)

Historical Summary of Groundwater Quality Data Collected by New Castle County for the Vicinity of the Army Creek and Delaware Sand & Gravel Landfills

Parameter	RW-10																					
	7/03	7/04	10/04	1/05	4/05	7/05	10/05	1/06	4/06	7/06	10/06	1/07	4/07	10/07	10/08	10/09	10/10	10/11	10/12	10/15	3/16	4/16
***Non-Halogenated VOCs* (µg/l)**																						
Benzene	0.2 J	0.1 J	0.5 U	5 U	5 U	5 U	5 U	10 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	--	--	--
Toluene	0.5 U	0.5 U	0.5 U	5 U	5 U	5 U	5 U	10 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	--	--	--
Ethylbenzene	0.5 U	0.5 U	0.29 J	5 U	5 U	5 U	5 U	10 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	--	--	--
Xylene (total)	1.0 U	1.0 U	1	5 U	5 U	5 U	5 U	10 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	--	--	--
2-Butanone	--	--	5 U	10 U	10 R	10 U	10 U	10 U	5 U	5 U	5 U	5 U	5 U	5 UJ	5 U	5 U	5 U	5 U	5 U	--	--	--
Acetone	--	--	5 U	20 U	20 R	20 R	20 R	10 U	5 UJ	6.6 U	5 U	5 U	5 U	5 UJ	5 U	5 U	7.5 U	5 U	5 U	--	--	--
Carbon Disulfide	--	--	0.5 U	--	--	--	--	10 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	--	--	--
Cyclohexane	--	--	0.5 U	--	--	--	--	10 U	1 U	1 U	1 U	1 U	1 UJ	1 UJ	1 U	1 U	1 U	1 U	1 U	--	--	--
Isopropylbenzene	--	--	0.5 U	--	--	--	--	10 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	--	--	--
Methy-tert-butyl ether	--	--	2.2	--	--	--	--	10 U	0.49 J	0.85 J	1 U	1 U	0.40 J	0.33 J	0.56 J	1 U	0.48 J	1 U	1 U	--	--	--
Methylcyclohexane	--	--	0.5 U	--	--	--	--	10 U	1 U	1 U	1 U	1 U	1 UJ	1 U	1 U	1 U	1 U	1 U	1 U	--	--	--
4-Methyl-2-pentanone	--	--	5 U	10 U	10 U	10 UJ	10 U	10 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	--	--	--
***Halogenated VOCs* (µg/l)**																						
Bromoform	0.5 U	0.5 U	0.5 U	5 U	5 U	5 U	5 U	10 U	1 U	1 U	1 UJ	1 U	1 UJ	1 U	1 U	1 U	1 U	1 U	1 U	--	--	--
Bromodichloromethane	0.5 U	0.5 U	0.5 U	5 U	5 U	5 U	5 U	10 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	--	--	--
Carbon Tetrachloride	0.5 U	0.5 U	0.5 U	5 U	5 U	5 U	5 U	10 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 UJ	1 U	--	--	--
Chlorobenzene	0.3 J	0.2 J	0.22 J	5 U	5 U	5 U	5 U	10 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	--	--	--
Chloroform	0.5 U	0.5 U	0.13 J	5 U	5 U	5 U	5 U	10 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	--	--	--
Chloromethane	0.5 U	0.5 U	0.5 U	5 U	5 U	5 U	5 U	10 U	1 U	1 U	1 U	0.21 J	1 U	1 UJ	1 U	1 U	1 U	1 U	1 U	--	--	--
Dibromochloromethane	0.5 U	0.5 U	0.5 U	5 U	5 U	5 U	5 U	10 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	--	--	--
1,2-Dichloroethane	1.7	0.8	0.64	5 U	5 U	5 U	5 U	10 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	--	--	--
1,3 Chlorobenzene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1,1-Dichloroethane	0.5 U	0.5 U	0.5 U	5 U	5 U	5 U	5 U	10 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	--	--	--
cis-1,2-Dichloroethene	0.5 U	0.5 U	0.5 U	5 U	5 U	5 U	5 U	10 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	--	--	--
trans-1,2-Dichloroethene	--	--	0.5 U	5 U	5 U	5 U	5 U	10 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	--	--	--
1,1-Dichloroethene	0.1 J	0.5 U	0.22 J	5 U	5 U	5 U	5 U	10 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	--	--	--
1,2-Dichloroethene (total)	1.0 U	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1,2-Dichlorobenzene	0.5 U	0.5 U	0.5 U	--	--	--	--	10 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	--	--	--
1,3-Dichlorobenzene	0.5 U	0.5 U	0.5 U	--	--	--	--	10 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	--	--	--
1,4-Dichlorobenzene	0.1 J	0.5 U	0.14 J	--	--	--	--	10 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	--	--	--
Chloroethane	0.5 U	0.5 U	0.5 U	5 U	5 U	5 U	5 U	10 UJ	1 R	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	--	--	--
Tetrachloroethene	4.4	2.7	6.3	7	7	5 U	5 U	10 U	0.53 J	0.49 J	0.32 J	0.53 J	0.39 J	0.29 J	0.27 J	0.29 J	0.29 J	0.30 J	0.34 J	--	--	--
1,1,1-Trichloroethane	0.5 U	0.2 J	0.58	1 J	0.8 J	5 U	5 U	10 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	--	--	--
Trichloroethene	0.5 U	0.5 U	0.1 J	5 U	5 U	5 U	5 U	10 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	--	--	--
Vinyl Chloride	0.5 U	0.5 U	0.5 U	5 U	5 U	5 U	5 U	10 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	--	--	--
1,2,4-Trichlorobenzene	--	--	0.5 U	--	--	--	--	10 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	--	--	--
cis-1,3-Dichloropropene	--	--	0.5 U	5 U	5 U	5 U	5 U	10 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	--	--	--
Methylene Chloride	--	--	0.5 U	5 U	5 U	5 U	5 U	10 U	1 U	1 UJ	1 U	1 U	1 U	1 UJ	1 U	1 U	1 U	1 U	1 U	--	--	--
Trichlorofluoromethane	--	--	0.5 U	--	--	--	--	10 UJ	1 UJ	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	--	--	--
***Semi-Volatiles* (µg/l)**																						
Bis(2-chloroethyl)Ether	0.05 U	--	0.054 U	0.019 U	0.02 U	0.02 U	0.018 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5.0 U	5.0 U	5.0 U	5.0 U	--	--	--
Bis(2-ethylhexyl)phthalate	--	--	5 U	5 U	5 U	5 U	5.9	160 D	5 UL	5 UL	5 U	5 UL	5 UL	5 U	5 U	5.0 U	5.0 U	5.0 U	5.0 U	--	--	--
2,2'-oxybis (1-Chloropropane)	--	--	5 U	5 U	5 U	5 U	5 U	5 UL	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5.0 U	5.0 U	5.0 U	5.0 U	--	--	--
2,4-Dimethylphenol	--	--	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5.0 U	5.0 U	5.0 U	5.0 U	--	--	--
2-Methylnaphthalene	--	--	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5.0 U	5.0 U	5.0 U	5.0 U	--	--	--
2-Methylphenol	--	--	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5.0 U	5.0 U	5.0 U	5.0 U	--	--	--
4-Methylphenol	--	--	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5.0 U	5.0 U	5.0 U	5.0 U	--	--	--
Acetophenone	--	--	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5.0 U	5.0 U	5.0 U	5.0 U	--	--	--
Caprolactam	--	--	5 UJ	5 U	5 U	5 UL	5 U	5 U	5 UL	5 UL	5 U	5 UL	5 UL	5 U	5 UJ	5.0 U	5.0 U	5.0 U	5.0 U	--	--	--
Diethylphthalate	--	--	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 UL	5 U	5 UL	5 UL	5 U	5 U	5.0 U	5.0 U	5.0 U	5.0 U	--	--	--
N-Nitrosodiphenylamine	--	--	5 U	5 U	5 UJ	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5.0 U	5.0 U	5.0 U	5.0 U	--	--	--
Naphthalene	--	--	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5.0 U	5.0 U	5.0 U	5.0 U	--	--	--
Phenol	--	--	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5.0 U	5.0 U	5.0 U	5.0 U	--	--	--
Inorganics (mg/l)																						
Dissolved Manganese	0.145	--	0.241	0.806	1.50	3.69	5.12	2.68	3.69	2.03	0.250	0.124	0.0424	0.0336	0.0165	0.0227	0.0075 J	0.0130 J	0.0090 J	0.0023 J	0.96	0.996
Dissolved Iron	0.221	--	0.511	2.35	7.61	3.88	0.269	2.85	0.146	1.46	0.0075 U	0.0153 U	0.010 U	0.009 U	0.0177 U	0.100 U	0.100 U	0.100 U	0.1 U	0.100 U	27.7	17.3
Dissolved Cobalt	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.0500 U	0.011	0.0102 J
Biological Oxygen Demand (mg/l)	--	--	--	--	0	1.7	< 1	1.4	< 2	< 2	< 2	--	--	--	--	--	--	--	--	--	--	--
Field Parameters																						
Temperature (Degrees Celcius)	14.07	--	14.5	13.43	14.15	15.65	13.88	13.1	14.1	14.6	14.2	13.0	14.7	15.3	13.9	13.6	14.7	15.3	12.8	13.1	10.4	13.1
Conductivity (µs/cm)	192.2	--	269	165	203	261	292	439	381	551	401	366	177	140	302	322	341	422	450	370	403	363
pH (standard units)	5.55	--	6.66	5.50	5.87	5.13	5.83	5.66	5.81	5.61	5.50	5.89	3.70	6.45	5.73	6.44	5.49	5.74	5.54	6.16	7.13	6.85
Dissolved Oxygen (mg/l)	0.27	--	--	8.80	3.59	2.19	0.70	0.00	1.20	1.20	1.23	0.77	0.83	4.56	3.94	4.92	0.00	4.13	2.81	4.13	0.00	0.00
ORP (mV)	96.5	--	57.1	150.7	68.7	183.6	231.2	63	232	98	240	218	259	191	255	196	196	235	277	217	-175	-130
Water-Level Elevation (ft, MSL)	-27.74	-26.17	-16.05	-11.30	-0.17	-6.95	-11.36	-0.96	-4.59	-8.21	-9.49	-6.20	-7.06	-11.30	-9.90	-10.06	-4.82	-7.55	-4.09	-7.05	-4.83	-4.66

-- Not analyzed or data not available to RAI as of November 29, 2016
U - Analyte was not detected above the reporting limit
J - Estimated concentration.
K - Analyte present, reported value may be biased high.
L - Analyte present, reported value may be biased low.
UL - Not detected, quantitation limit is probably higher

D - Sample diluted in the lab for analysis.
NP - Well not pumping
P - Discrepency in GC analysis. Lower value reported
B - Analyte Detected in Method Blank

Attachment Table 1-1 (continued)

Historical Summary of Groundwater Quality Data Collected by New Castle County for the Vicinity of the Army Creek and Delaware Sand & Gravel Landfills

Parameter	P-4															
	1/07	4/07	7/07	10/07	1/08	4/08	7/08	10/08	1/09	4/09	10/09	4/10	10/10	4/11	10/11	4/12
Non-Halogenated VOCs **(µg/l)**																
Benzene	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	0.32 J	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Toluene	1.2	0.92 J	1.0 U	1.0 UJ	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Ethylbenzene	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Xylene (total)	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
2-Butanone	5.0 U	5.0 U	5.0 U	5.0 UJ	5.0 U	5.0 U	5.0 U	5.0 U	5.0 UJ	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 UJ
Acetone	5.0 U	5.0 U	4.1 J	5 UJ	5.0 U	5.0 U	5.0 U	5.0 U	5.0 UJ	5.0 UJ	5.0 U	5.0 U	7.3 U	5.0 U	5.0 U	5.0 UJ
Carbon Disulfide	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 UJ	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Cyclohexane	1.0 U	1.0 UJ	1.0 U	1.0 UJ	1.0 U	1.0 U	1.0 U	1.0 U	1.0 UJ	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Isopropylbenzene	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Methy-tert-butyl ether	0.63 J	1.0 U	1.0 U	1.0 U	1.0 U	3.3	0.65 J	7.0	5.2	9.7	0.54 J	0.22 J	1.0 U	1.0 U	1.0 U	1.0 U
Methylcyclohexane	1.0 U	1.0 UJ	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
4-Methyl-2-pentanone	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 UJ	5.0 UJ	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 UJ
Halogenated VOCs **(µg/l)**																
Bromoform	1.0 U	1.0 U	1.0 UJ	1.0 U	1.0 UJ	1.0 U	1.0 U	1.0 U	1.0 U	1.0 UJ	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Bromodichloromethane	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Carbon Tetrachloride	1.0 U	1.0 U	1.0 U	1.0 U	1.0 UJ	1.0 UJ	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 UJ	1.0 U
Chlorobenzene	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	0.37 J	1.0 U	0.59 J	0.46 J	1.3	0.16 J	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Chloroform	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Dibromochloromethane	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
1,2-Dichloroethane	0.91 J	0.21 J	1.0 U	0.3 J	0.28 JB	18	3.6	19	19	28	2.2	0.57 J	1.0 U	1.0 U	1.0 U	1.0 U
1,3 Chlorobenzene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1,1-Dichloroethane	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
cis-1,2-Dichloroethene	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
trans-1,2-Dichloroethene	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
1,1-Dichloroethene	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
1,2-Dichloroethene (total)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1,2-Dichlorobenzene	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
1,3-Dichlorobenzene	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
1,4-Dichlorobenzene	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	0.22 J	1.0 U	0.21 J	1.0 U	0.43 J	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Chloroethane	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Chloromethane	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	0.56 J	1.0 U	1.0 UJ	1.0 U	1.0 U	1.0 UJ	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Tetrachloroethene	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
1,1,1-Trichloroethane	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Trichloroethene	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Vinyl Chloride	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
1,2,4-Trichlorobenzene	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
cis-1,3-Dichloropropene	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Methylene Chloride	1.0 U	1.0 U	1.0 UJ	1.0 UJ	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Trichlorofluoromethane	1.0 U	1.0 UJ	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Semi-Volatiles **(µg/l)**																
Bis(2-chloroethyl)Ether	5 U	5 U	5 U	5 UL	5 U	5 U	5 U	5.3 U	5.1 U	5.0 U	4.9 U	5 U	5 U	5 U	5 U	5 U
Bis(2-ethylhexyl)phthalate	5 U	5 U	5 U	5 UL	5 U	5 UL	5 U	5.3 U	5.1 UJ	5.0 U	4.9 U	5 U	5 U	5 U	5 U	5 U
2,2'-oxybis (1-Chloropropane)	5 U	5 U	5 U	5 UL	5 U	5 U	5 U	5.3 U	5.1 U	5.0 U	4.9 U	5 U	5 U	5 U	5 U	5 U
2,4-Dimethylphenol	5 U	5 U	5 U	5 UL	5 U	5 U	5 U	5.3 U	5.1 U	5.0 U	4.9 U	5 U	5 U	5 U	5 U	5 U
2-Methylnaphthalene	5 U	5 U	5 U	5 UL	5 U	5 U	5 U	5.3 U	5.1 U	5.0 U	4.9 U	5 U	5 U	5 U	5 U	5 U
2-Methylphenol	5 U	5 U	5 U	5 UL	5 U	5 U	5 U	5.3 U	5.1 U	5.0 U	4.9 U	5 U	5 U	5 U	5 U	5 U
4-Methylphenol	5 U	5 U	5 U	5 UL	5 U	5 U	5 U	5.3 U	5.1 U	5.0 U	4.9 U	5 U	5 U	5 U	5 U	5 U
Acetophenone	5 U	5 U	5 U	5 UL	5 U	5 U	5 U	5.3 U	5.1 U	5.0 U	4.9 U	5 U	5 U	5 U	5 U	5 U
Caprolactam	5 U	2.9 R	5 UJ	5 UL	5 UJ	5 UL	5 U	5.3 UJ	5.1 U	5.0 R	4.9 U	5 U	5 U	5 U	5 U	5 U
Diethylphthalate	5 U	5 U	5 U	5 UL	5 U	5 UL	5 U	5.3 U	5.1 U	5.0 U	4.9 U	5 U	5 U	5 U	5 U	5 U
N-Nitrosodiphenylamine	5 U	5 U	5 U	5 UL	5 U	5 U	5 U	5.3 U	5.1 U	5.0 U	4.9 U	5 U	5 U	5 U	5 U	5 U
Naphthalene	5 U	5 U	5 U	5 UL	5 U	5 U	5 U	5.3 U	5.1 U	5.0 U	4.9 U	5 U	5 U	5 U	5 U	5 U
Phenol	5 U	5 U	5 U	5 UL	5 U	5 U	5 U	5.3 U	5.1 U	5.0 U	4.9 U	5 U	5 U	5 U	5 U	5 U
Inorganics **(mg/l)**																
Dissolved Manganese	0.234	0.0511	0.0606	0.0437	0.0532	0.997	0.593	1.11	1.01	1.50	0.136	0.0399	0.0052 J	0.015 U	0.015 U	0.0031 J
Dissolved Iron	0.102	0.924	1.61	0.18	0.160 U	28.9	12.7	36.4	35.6	60.6	0.157	0.100 U	0.100 U	0.100 U	0.100 U	0.100 U
Dissolved Cobalt	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Biological Oxygen Demand (mg/l)	--	--	--	--	2	--	--	--	--	--	--	--	--	--	--	--
Field Parameters																
Temperature (Degrees Celcius)	13.6	14.8	18.3	15.1	13.4	14.8	15.0	14.4	13.2	14.3	14.7	13.9	14.7	16.0	15.0	14.5
Conductivity (µs/cm)	156	92	305	257	309	306	172	433	307	716	242	246	120	125	122	132
pH (standard units)	6.40	6.18	6.55	6.46	6.47	6.38	5.69	7.37	6.30	6.58	6.66	6.90	6.59	6.34	6.98	6.91
Dissolved Oxygen (mg/l)	0.00	0.00	0.00	0.00	0.00	0.00	0.59	0.00	0.23	0.00	0.00	0.00	0.85	3.89	3.74	3.07
ORP (mV)	-45	-75	6	19	145	-93	159	-93	-93	-99	275	128	123	163	168	111
Water-Level Elevation (ft, MSL)	-10.41	-11.95	-14.15	-15.12	-11.49	-12.36	-15.97	-13.69	-12.05	-9.81	-13.71	-7.05	-9.02	-8.24	-12.56	-6.95

-- Not analyzed or data not available to RAI as of November 29, 2016
U - Analyte was not detected above the reporting limit
J - Estimated concentration.
K - Analyte present, reported value may be biased high.
L - Analyte present, reported value may be biased low.
UL - Not detected, quantitation limit is probably higher

D - Sample diluted in the lab for analysis.
NP - Well not pumping
P - Discrepency in GC analysis. Lower value reported
B - Analyte Detected in Method Blank
R - Data Rejected

Attachment Table 1-1 (continued)

st orical Summary of Groundwater Quality Data Collected by New Castle County for the Vicinity of the Army Creek and Delaware Sand & Gravel Land

Parameter	P-4							
	10/12	4/13	10/13	10/14	10/15	2/16	10/16	10/17
***Non-Halogenated VOCs* (µg/l)**								
Benzene	1.0 U	1.0 U	1.0 U	0.50 U	1.0 U	--	0.50 U	0.50 U
Toluene	1.0 U	1.0 U	1.0 U	0.50 U	1.0 U	--	0.50 U	0.50 U
Ethylbenzene	1.0 U	1.0 U	1.0 U	0.50 U	1.0 U	--	0.50 U	0.50 U
Xylene (total)	1.0 U	1.0 U	1.0 U	1.5 U	1.0 U	--	0.50 U	0.50 U
2-Butanone	5.0 U	5.0 U	5.0 U	50 UJ	5.0 U	--	10 U	10 U
Acetone	5.0 U	5.0 U	5.0 U	5.0 UJ	5.0 U	--	10 U	10 UJ
Carbon Disulfide	1.0 U	1.0 U	1.0 U	0.50 U	1.0 U	--	0.50 U	0.50 U
Cyclohexane	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	--	0.50 U	0.50 U
Isopropylbenzene	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	--	0.50 U	0.50 U
Methy-tert-butyl ether	1.0 U	1.4	1.8	1.5	0.96 J	--	1.9	1.5
Methylcyclohexane	1.0 U	1.0 U	1.0 U	0.50 U	1.0 U	--	5.0 U	5.0 U
4-Methyl-2-pentanone	5.0 U	5.0 U	5.0 UJ	5.0 UJ	5.0 U	--	10 U	10 U
***Halogenated VOCs* (µg/l)**								
Bromoform	1.0 U	1.0 U	1.0 UJ	0.50 U	1.0 U	--	0.50 U	0.50 U
Bromodichloromethane	1.0 U	1.0 U	1.0 U	0.50 U	1.0 U	--	0.50 U	0.50 U
Carbon Tetrachloride	1.0 U	1.0 U	1.0 U	0.50 U	1.0 U	--	0.50 U	0.50 U
Chlorobenzene	1.0 U	0.42 J	0.64 J	0.50 U	0.26 J	--	0.50 U	0.63
Chloroform	1.0 U	1.0 U	1.0 U	0.50 U	1.0 U	--	0.50 U	0.50 U
Dibromochloromethane	1.0 U	1.0 U	1.0 U	0.50 U	1.0 U	--	0.50 U	0.50 U
1,2-Dichloroethane	1.0 U	1.0 U	8.1	14	6.7	--	15	16
1,3 Chlorobenzene	--	--	--	--	--	--	--	--
1,1-Dichloroethane	1.0 U	1.0 U	1.0 U	0.50 U	1.0 U	--	0.50 U	0.50 U
cis-1,2-Dichloroethene	1.0 U	1.0 U	1.0 U	0.50 U	1.0 U	--	0.50 U	0.50 U
trans-1,2-Dichloroethene	1.0 U	1.0 U	1.0 U	0.50 U	1.0 U	--	0.50 U	0.50 U
1,1-Dichloroethene	1.0 U	1.0 U	1.0 U	0.50 U	1.0 U	--	0.50 U	0.50 U
1,2-Dichloroethene (total)	--	--	--	--	--	--	--	--
1,2-Dichlorobenzene	1.0 U	1.0 U	1.0 U	0.50 U	1.0 U	--	0.50 U	0.50 U
1,3-Dichlorobenzene	1.0 U	1.0 U	1.0 U	0.50 U	1.0 U	--	0.50 U	0.50 U
1,4-Dichlorobenzene	1.0 U	1.0 U	1.0 U	0.50 U	1.0 U	--	0.50 U	0.50 U
Chloroethane	1.0 U	1.0 U	1.0 U	0.50 U	1.0 U	--	0.50 U	0.50 U
Chloromethane	1.0 U	1.0 U	1.0 U	0.50 UJ	1.0 U	--	0.50 U	0.50 U
Tetrachloroethene	1.0 U	1.0 U	1.0 U	0.50 U	1.0 U	--	0.50 U	0.50 U
1,1,1-Trichloroethane	1.0 U	1.0 U	1.0 U	0.50 U	1.0 U	--	0.50 U	0.50 U
Trichloroethene	1.0 U	1.0 U	1.0 U	0.50 U	1.0 U	--	0.50 U	0.50 U
Vinyl Chloride	1.0 U	1.0 U	1.0 U	0.50 U	1.0 U	--	0.50 U	0.50 U
1,2,4-Trichlorobenzene	1.0 U	1.0 U	1.0 U	0.50 UJ	1.0 U	--	0.50 U	0.50 U
cis-1,3-Dichloropropene	1.0 U	1.0 U	1.0 U	0.50 U	1.0 U	--	0.50 U	0.50 U
Methylene Chloride	1.0 U	1.0 UJ	1.0 U	5.0 U	1.0 U	--	0.68	0.50 U
Trichlorofluoromethane	1.0 U	1.0 U	1.0 U	0.50 U	1.0 U	--	0.50 U	0.50 U
***Semi-Volatiles* (µg/l)**								
Bis(2-chloroethyl)Ether	5 U	5 U	5 U	5 U	0.10 U	--	0.10 U	0.10 U
1,4-Dioxane	--	--	--	--	--	--	--	2.0 U
Bis(2-ethylhexyl)phthalate	5 U	4.7 J	7.2 U	5 U	5 U	--	5.0 U	5.0 U
2,2'-oxybis (1-Chloropropane)	5 U	5 U	5 U	5 U	5 U	--	10 U	10 U
2,4-Dimethylphenol	5 U	5 U	5 U	5 U	5 U	--	5.0 U	5.0 U
2-Methylnaphthalene	5 U	5 U	5 U	5 U	5 U	--	5.0 U	5.0 U
2-Methylphenol	5 U	5 U	5 U	5 U	5 U	--	10 U	10 U
4-Methylphenol	5 U	5 U	5 U	5 U	5 U	--	10 U	10 U
Acetophenone	5 U	5 U	5 U	5 U	5 U	--	10 U	10 U
Caprolactam	5 U	5 UJ	5 U	5 UJ	1.6 J	--	10 U	10 U
Diethylphthalate	5 U	5 U	5 U	5 U	5 U	--	5.0 U	5.0 U
N-Nitrosodiphenylamine	5 U	5 U	5 U	5 U	5 U	--	5.0 U	5.0 U
Naphthalene	5 U	5 U	5 U	5 U	5 U	--	5.0 U	5.0 U
Phenol	5 U	5 U	5 U	5 U	5 U	--	10 U	10 U
***Inorganics* (mg/l)**								
Dissolved Manganese	0.0150 U	0.975	1.19	2.1 J	1.36	3.2	3.44	3.81
Dissolved Iron	0.1 U	29.9	34.6	45.8	33.5	77.6	81.5	81.2
Dissolved Cobalt	--	--	--	--	0.108	0.24	0.223	0.246
Biological Oxygen Demand (mg/l)	--	--	--	--	--	--	--	--
Field Parameters								
Temperature (Degrees Celcius)	13.6	14.6	15.9	13.3	14.1	14.5	13.3	12.9
Conductivity (µs/cm)	146	895	1120	1710	2410	5470	7010	8710
pH (standard units)	6.88	5.57	6.37	6.50	6.74	6.70	6.60	6.57
Dissolved Oxygen (mg/l)	4.30	1.47	0.00	0.39	0.00	0.22	0.00	0.00
ORP (mV)	206	-18	-61	-116	-46	-75	-109	-57
Water-Level Elevation (ft, MSL)	-7.88	-8.68	-8.12	-10.08	-11.81	-10.18	-16.00	-14.73

-- Not analyzed or data not available to RAI as of November 29, 2016
U - Analyte was not detected above the reporting limit
J - Estimated concentration.
K - Analyte present, reported value may be biased high.
L - Analyte present, reported value may be biased low.
UL - Not detected, quantitation limit is probably higher

D - Sample diluted in the lab for analysis.
NP - Well not pumping
P - Discrepency in GC analysis. Lower value reported
B - Analyte Detected in Method Blank
R - Data Rejected

Attachment Table 1-1 (continued)

Historical Summary of Groundwater Quality Data Collected by New Castle County for the Vicinity of the Army Creek and Delaware Sand & Gravel Landfills

Parameter	MW-22N																	
	7/00	12/00	4/01	7/01	10/01	1/02	4/02	7/02	10/02	1/03	4/03	7/03	10/04	1/05	4/05	7/05	10/05	1/06
***Non-Halogenated VOCs* (µg/l)**																		
Benzene	--	--	1 U	1 U	--	--	--	--	--	--	0.5 U	0.5 U	0.41 J	5 U	5 U	5 U	5 U	10 U
Toluene	--	--	0.1 B	1 U	--	--	--	--	--	--	0.5 U	0.5 U	0.5 U	5 U	5 U	5 U	5 U	10 U
Ethylbenzene	--	--	1 U	1 U	--	--	--	--	--	--	0.5 U	0.5 U	0.5 U	5 U	5 U	5 U	5 U	10 U
Xylene (total)	--	--	1 U	1 U	--	--	--	--	--	--	0.5 U	0.24 JB	0.5 U	5 U	5 U	5 U	5 U	10 U
2-Butanone	--	--	--	--	--	--	--	--	--	--	--	--	1.9 J	10 R	10 R	10 R	10 U	10 U
Acetone	--	--	--	--	--	--	--	--	--	--	--	--	5 UJ	20 R	20 R	20 R	20 R	10 U
Carbon Disulfide	--	--	--	--	--	--	--	--	--	--	--	--	0.5 U	5 U	5 U	5 U	5 U	10 U
Cyclohexane	--	--	--	--	--	--	--	--	--	--	--	--	0.5 U	--	--	--	--	10 U
Isopropylbenzene	--	--	--	--	--	--	--	--	--	--	--	--	0.5 U	--	--	--	--	10 U
Methy-tert-butyl ether	--	--	--	--	--	--	--	--	--	--	--	--	0.56	--	--	--	--	10 U
Methylcyclohexane	--	--	--	--	--	--	--	--	--	--	--	--	0.5 U	--	--	--	--	10 U
4-Methyl-2-pentanone	--	--	--	--	--	--	--	--	--	--	--	--	5 U	10 U	10 U	10 U	10 U	10 U
***Halogenated VOCs* (µg/l)**																		
Bromoform	--	--	1 U	1 U	--	--	--	--	--	--	0.5 U	0.5 U	0.14 J	5 U	5 U	5 U	5 U	10 UJ
Bromodichloromethane	--	--	1 U	1 U	--	--	--	--	--	--	0.5 U	0.5 U	0.5 U	5 U	5 U	5 U	5 U	10 U
Carbon Tetrachloride	--	--	1 U	1 U	--	--	--	--	--	--	0.5 U	0.5 U	0.5 U	5 U	5 U	5 U	5 U	10 UJ
Chlorobenzene	--	--	1 U	1 U	--	--	--	--	--	--	0.5 U	0.5 U	1.4	0.9 J	5 U	5 U	5 U	10 U
Chloroform	--	--	1 U	0.2 J	--	--	--	--	--	--	0.2 J	6.2 J	0.13 J	5 U	5 U	5 U	5 U	10 U
Dibromochloromethane	--	--	1 U	1 U	--	--	--	--	--	--	0.5 U	0.5 U	0.5 U	5 U	5 U	5 U	5 U	10 U
1,2-Dichloroethane	--	--	0.8 J	3	--	--	--	--	--	--	0.5	0.16 J	19 D	17	5 U	5 U	5 U	10 U
1,3 Chlorobenzene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1,1-Dichloroethane	--	--	1 U	1 U	--	--	--	--	--	--	0.5 U	0.5 U	0.17 J	5 U	5 U	5 U	5 U	10 U
cis-1,2-Dichloroethene	--	--	1 U	1 U	--	--	--	--	--	--	0.09 J	0.04 J	0.36 J	5 U	5 U	5 U	5 U	10 U
trans-1,2-Dichloroethene	--	--	--	--	--	--	--	--	--	--	--	--	0.12 J	5 U	5 U	5 U	5 U	10 U
1,1-Dichloroethene	--	--	1 U	1 U	--	--	--	--	--	--	0.5 U	0.5 U	0.5 U	5 U	5 U	5 U	5 U	10 U
1,2-Dichloroethene (total)	--	--	2 U	2 U	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1,2-Dichlorobenzene	--	--	1 U	1 U	--	--	--	--	--	--	0.5 U	0.5 U	0.12 J	--	--	--	--	10 U
1,3-Dichlorobenzene	--	--	1 U	1 U	--	--	--	--	--	--	0.5 U	0.5 U	0.5 U	--	--	--	--	10 U
1,4-Dichlorobenzene	--	--	1 U	0.2 B	--	--	--	--	--	--	0.5 U	0.5 U	0.66	--	--	--	--	10 U
Chloroethane	--	--	1 U	1 U	--	--	--	--	--	--	0.5 U	0.5 U	0.16 K	5 U	5 U	5 U	5 U	10 U
Chloromethane	--	--	1 U	1 U	--	--	--	--	--	--	0.5 U	0.5 U	0.5 U	5 U	5 U	5 U	5 U	10 U
Tetrachloroethene	--	--	1 U	1 U	--	--	--	--	--	--	0.05 J	0.5 U	0.5 U	5 U	5 U	5 U	5 U	10 U
1,1,1-Trichloroethane	--	--	1 U	1 U	--	--	--	--	--	--	0.5 U	0.5 U	0.5 U	5 U	5 U	5 U	5 U	10 U
Trichloroethene	--	--	0.2 J	0.3 J	--	--	--	--	--	--	0.2 J	0.5 U	0.32 J	5 U	5 U	5 U	5 U	10 U
Vinyl Chloride	--	--	1 U	1 U	--	--	--	--	--	--	0.5 U	0.5 U	0.5 U	5 U	5 U	5 U	5 U	10 U
1,2,4-Trichlorobenzene	--	--	--	--	--	--	--	--	--	--	--	--	0.5 U	--	--	--	--	10 U
cis-1,3-Dichloropropene	--	--	--	--	--	--	--	--	--	--	--	--	0.5 U	5 U	5 U	5 U	5 U	10 U
Methylene Chloride	--	--	--	--	--	--	--	--	--	--	--	--	0.5 U	5 U	5 U	5 U	5 U	10 U
Trichlorofluoromethane	--	--	--	--	--	--	--	--	--	--	--	--	1	--	--	--	--	10 U
***Semi-Volatiles* (µg/l)**																		
Bis(2-chloroethyl)Ether	0.05 U	0.024 U	0.02 U	0.024 U	0.025 U	0.024 U	0.014 J	0.04 U	0.05 U	0.05 J	0.05 U	0.05 U	0.017 J	0.053 B	0.039	0.02 U	0.018 U	0.018 U
Bis(2-ethylhexyl)phthalate	--	--	--	--	--	--	--	--	--	--	--	--	5 U	5 U	5 U	17	5 U	23 U
2,2'-oxybis (1-Chloropropane)	--	--	--	--	--	--	--	--	--	--	--	--	5 UJ	5 U	5 U	5 U	5 U	5 UL
2,4-Dimethylphenol	--	--	--	--	--	--	--	--	--	--	--	--	5 U	5 U	5 U	5 UL	5 U	5 U
2-Methylnaphthalene	--	--	--	--	--	--	--	--	--	--	--	--	5 U	5 U	5 U	5 U	5 U	5 U
2-Methylphenol	--	--	--	--	--	--	--	--	--	--	--	--	5 U	5 U	5 U	5 UL	5 U	5 U
4-Methylphenol	--	--	--	--	--	--	--	--	--	--	--	--	5 U	5 U	5 U	5 UL	5 U	5 U
Acetophenone	--	--	--	--	--	--	--	--	--	--	--	--	5 U	5 U	5 U	5 U	5 U	5 U
Caprolactam	--	--	--	--	--	--	--	--	--	--	--	--	5 U	5 U	5 U	5 UL	5 U	5 UL
Diethylphthalate	--	--	--	--	--	--	--	--	--	--	--	--	5 U	5 U	5 U	5 U	5 U	5 U
N-Nitrosodiphenylamine	--	--	--	--	--	--	--	--	--	--	--	--	5 U	5 U	5 UJ	5 U	5 U	5 U
Naphthalene	--	--	--	--	--	--	--	--	--	--	--	--	5 U	5 U	5 U	5 U	5 U	5 U
Phenol	--	--	--	--	--	--	--	--	--	--	--	--	5 U	5 U	5 U	5 U	5 U	5 U
***Inorganics* (mg/l)**																		
Dissolved Manganese	--	--	--	--	--	--	--	--	--	--	--	0.799	1.53	1.83	0.852	0.975	0.004 B	0.807
Dissolved Iron	--	--	0.023 B	0.011 U	--	--	--	--	--	--	0.0142 U	0.0234 U	0.132	0.0112 U	0.0273 U	0.028 U	0.027 U	0.0153 U
Dissolved Lead	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Biological Oxygen Demand (mg/l)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0	< 1	< 1	< 1
Field Parameters																		
Temperature (Degrees Celcius)	13.4	13.35	13.35	13.47	--	13.13	14.14	--	15.28	14.48	14.4	14.69	13.58	13.99	13.37	14.94	13.80	13.8
Conductivity (µs/cm)	0.081	0.073	82.11	126	--	148.3	146.1	--	129.4	165	145.7	160.4	226	161	158	120	55	171
pH (standard units)	5.28	6.21	5.22	5.62	--	6.12	5.33	--	5.55	5.89	5.1	5.16	6.52	5.88	6.15	4.89	5.19	5.40
Dissolved Oxygen (mg/l)	--	1.3	0.76	0.56	--	2.4	0.72	0.92	0	0.05	0.2	0.33	0.12	0.04	1.15	1.54	3.12	0.01
ORP (mV)	260	223.8	402.9	226.4	--	268.9	307.5	--	283.2	220.5	232.4	8.3	129.8	114.3	146.5	218	279.5	227
Water-Level Elevation (ft, MSL)	-27.66	-18.17	-23.44	-27.05	-31.74	-30.03	-28.29	-35.08	-31.93	-32.62	-29.33	-22.39	-22.20	-17.93	-3.71	-14.10	-21.39	-3.93

-- Not analyzed or data not available to RAI as of November 29, 2016
U - Analyte was not detected above the reporting limit
J - Estimated concentration.
K - Analyte present, reported value may be biased high.
L - Analyte present, reported value may be biased low.
UL - Not detected, quantitation limit is probably higher

D - Sample diluted in the lab for analysis.
NP - Well not pumping
P - Discrepency in GC analysis. Lower value reported
B - Analyte Detected in Method Blank
R - Data Rejected

Attachment Table 1-1 (continued)

Historical Summary of Groundwater Quality Data Collected by New Castle County for the Vicinity of the Army Creek and Delaware Sand & Gravel Landfills

Parameter	MW-22N																	
	4/06	7/06	10/06	1/07	4/07	7/07	10/07	1/08	4/08	7/08	10/08	1/09	4/09	10/09	10/10	10/11	10/12	10/13
***Non-Halogenated VOCs* (µg/l)**																		
Benzene	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Toluene	1 U	0.23 J	1 U	1 U	1 U	0.22 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Ethylbenzene	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Xylene (total)	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U
2-Butanone	5 U	5 U	5 U	5 U	5 U	5 U	5 UJ	5 U	5 U	5 U	5 U	5 UJ	5 U	5 U	5 U	5 U	5 U	5 U
Acetone	5 UJ	7.8 U	5 U	5 U	5 U	2.8 J	3.1 J	5 U	5 U	8.9 U	5 U	5 UJ	5 UJ	5 U	15 U	5 U	5 U	5 U
Carbon Disulfide	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Cyclohexane	1 U	1 U	1 U	1 U	1 UJ	1 U	1 UJ	1 U	1 U	1 U	1 U	1 UJ	1 U	1 U	1 U	1 U	1 U	1 U
Isopropylbenzene	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Methy-tert-butyl ether	1 U	1 U	1 U	1 U	0.31 J	0.28 J	0.37 J	0.24 J	0.63 J	0.75 J	0.36 J	0.41 J	0.82 J	0.97 J	0.71 J	1.2	0.63 J	0.82 J
Methylcyclohexane	1 U	1 U	1 U	1 U	1 UJ	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
4-Methyl-2-pentanone	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 UJ	5 U	5 U	5 U	5 U	5 U	5 U
***Halogenated VOCs* (µg/l)**																		
Bromoform	1 U	1 UJ	1 U	1 U	1 U	1 UJ	1 U	1 UJ	1 U	1 U	1 U	1 U	1 UJ	1 UJ	1 U	1 U	1 U	1 U
Bromodichloromethane	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Carbon Tetrachloride	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 UJ	1 UJ	1 U	1 U	1 U	1 U	1 U	1 U	1 UJ	1 U	1 U
Chlorobenzene	1 U	1 U	0.22 J	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Chloroform	0.11 J	1 U	0.11 J	1 U	1 U	0.11 J	0.18 J	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Dibromochloromethane	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,2-Dichloroethane	1 U	0.28 J	1 U	2.4	4.4	1.5	3.2	5.9	3.4	1 U	1 U	1 U	1 U	1.3	0.63 J	0.48 J	0.46 J	0.53 J
1,3 Chlorobenzene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1,1-Dichloroethane	1 U	1 U	1 U	1 U	1 U	1 U	0.29 J	0.35 J	0.35 J	1 U	0.27 J	0.44 J	1 U	1 U	1 U	1 U	1 U	1 U
cis-1,2-Dichloroethene	1 U	1 U	1 U	1 U	1 U	1 U	1 U	0.14 J	0.14 J	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
trans-1,2-Dichloroethene	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,1-Dichloroethene	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,2-Dichloroethene (total)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1,2-Dichlorobenzene	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,3-Dichlorobenzene	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,4-Dichlorobenzene	1 U	1 U	1 U	1 U	0.12 J	1 U	0.16 J	0.13 J	0.26 J	0.13 J	1 U	0.24 J	1 U	1 U	1 U	1 U	1 U	1 U
Chloroethane	1 R	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Chloromethane	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	0.37 J	1 U	1 U	1 U	1 U	1 UJ	1 U	1 U	1 U	1 U
Tetrachloroethene	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	0.19 J	0.35 J	1 U	1 U	1 U	2.8	2.2	2.9	5.1	4.9
1,1,1-Trichloroethane	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Trichloroethene	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	0.16 J
Vinyl Chloride	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,2,4-Trichlorobenzene	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
cis-1,3-Dichloropropene	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Methylene Chloride	1 U	1 UJ	1 U	1 U	1 U	1 UJ	1 UJ	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Trichlorofluoromethane	1 UJ	1 U	0.65 J	1 U	1 UJ	1 U	1 U	0.62 J	0.39 J	1 U	0.24 J	0.16 J	1 U	1 U	1 U	1 U	0.23 J	0.22 J
***Semi-Volatiles* (µg/l)**																		
Bis(2-chloroethyl)Ether	0.018 U	0.019 U	0.019 U	0.020 U	0.018 U	0.020 U	0.020 U	0.020 U	0.019 U	0.019 U	0.020 U	0.051	0.020 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Bis(2-ethylhexyl)phthalate	8.0 L	70 J	86 DK	6.2 J	120 JD	27 J	15 J	5 U	5 U	14	5 U	5 UJ	5 U	2.6 J	5.0 U	5.0 U	5.0 U	5.0 U
2,2'-oxybis (1-Chloropropane)	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
2,4-Dimethylphenol	5 U	5 U	5 U	5 U	5 U	5 U	5 UL	5 U	5 UL	5 UL	5 UL	5 U	5 UL	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
2-Methylnaphthalene	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
2-Methylphenol	5 U	5 U	5 U	5 U	5 U	5 U	5 UL	5 U	5 UL	5 UL	5 UL	5 U	5 UL	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
4-Methylphenol	5 U	5 U	5 U	5 U	5 U	5 U	5 UL	5 U	5 UL	5 UL	5 UL	5 U	5 UL	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Acetophenone	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Caprolactam	5 UL	5 U	5 U	5 U	5 U	5 UJ	5 U	5 UJ	5 U	5 U	5 UJ	5 U	5 R	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Diethylphthalate	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
N-Nitrosodiphenylamine	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Naphthalene	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Phenol	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
***Inorganics* (mg/l)**																		
Dissolved Manganese	0.782	0.641	0.498	0.587	0.550	0.136	0.541	0.107	0.380	0.459	0.348	0.255	0.267	0.191	0.015 U	0.183	0.0817	0.0137 J
Dissolved Iron	0.0101 U	0.0124 U	0.011 U	0.0091 U	0.010 U	0.0153 U	0.009 U	0.0212 U	0.100 U	0.0126 U	0.0217 U	0.0246 U	0.0396 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
Dissolved Lead	--	--	--	--	--	--	--	--	--	--	--	--	--	0.010 U	0.010 U	0.010 U	0.010 U	--
Dissolved Cobalt	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Biological Oxygen Demand (mg/l)	< 2	3	< 2	--	--	--	--	2	--	--	--	--	--	--	--	--	--	--
Field Parameters																		
Temperature (Degrees Celcius)	15.0	17.6	16.6	14.9	20.5	18.2	15.7	14.6	16.8	17.2	15.7	13.6	16.8	15.1	18.8	15.4	15.3	14.9
Conductivity (µs/cm)	229	208	195	194	141	198	181	416	429	313	244	215	353	349	407	333	379	321
pH (standard units)	6.08	6.01	6.02	6.46	6.26	9.47	7.39	9.61	6.43	6.55	6.40	6.44	6.86	6.77	11.37	6.71	6.54	5.43
Dissolved Oxygen (mg/l)	0.55	0.57	1.16	0.00	0.04	0.00	0.19	0.92	1.08	0.83	0.32	0.53	0.28	0.00	1.15	0.62	0.29	0.00
ORP (mV)	225	143	146	147	152	-29	99	21	150	126	120	150	60	76	-103	190	171	221
Water-Level Elevation (ft, MSL)	-10.68	-15.95	-15.60	-11.09	-14.97	-16.99	-18.22	-14.25	-15.35	-19.04	-15.94	-13.98	-11.82	-15.84	-11.86	-15.51	-10.04	-11.03

-- Not analyzed or data not available to RAI as of November 29, 2016
U - Analyte was not detected above the reporting limit
J - Estimated concentration.
K - Analyte present, reported value may be biased high.
L - Analyte present, reported value may be biased low.
UL - Not detected, quantitation limit is probably higher

D - Sample diluted in the lab for analysis.
NP - Well not pumping
P - Discrepency in GC analysis. Lower value reported
B - Analyte Detected in Method Blank
R - Data Rejected

Attachment Table 1-1 (continued)

Historical Summary of Groundwater Quality Data Collected by New Castle County for the Vicinity of the Army Creek and Delaware Sand & Gravel Landfills

Parameter	MW-22N							
	10/14	4/15	10/15	3/16	4/16	10/16	4/17	10/17
***Non-Halogenated VOCs* (µg/l)**								
Benzene	0.50 U	--	1.0 U	--	--	0.50 U	--	0.50 U
Toluene	0.50 U	--	1.0 U	--	--	0.50 U	--	0.50 U
Ethylbenzene	0.50 U	--	1.0 U	--	--	0.50 U	--	0.50 U
Xylene (total)	1.5 U	--	3.0 U	--	--	0.50 U	--	0.50 U
2-Butanone	50 UJ	--	5.0 U	--	--	10 U	--	10 U
Acetone	5.0 UJ	--	5.0 U	--	--	10 U	--	10 UJ
Carbon Disulfide	0.50 U	--	1.0 U	--	--	0.50 U	--	0.50 U
Cyclohexane	1.0 U	--	1.0 U	--	--	0.50 U	--	0.50 U
Isopropylbenzene	1.0 U	--	1.0 U	--	--	0.50 U	--	0.50 U
Methy-tert-butyl ether	0.54	--	0.53 J	--	--	0.50	--	0.50 U
Methylcyclohexane	0.50 U	--	1.0 U	--	--	5.0 U	--	5.0 U
4-Methyl-2-pentanone	5.0 UJ	--	5.0 U	--	--	10 U	--	10 U
***Halogenated VOCs* (µg/l)**								
Bromoform	0.50 U	--	1.0 U	-	-	0.50 U	-	0.50 U
Bromodichloromethane	0.50 U	--	1.0 U	-	-	0.50 U	-	0.50 U
Carbon Tetrachloride	0.50 U	--	1.0 U	-	-	0.50 U	-	0.50 U
Chlorobenzene	0.50 U	--	1.0 U	-	-	0.50 U	-	0.50 U
Chloroform	0.50 U	--	0.25 J	-	-	0.50 U	-	0.50 U
Dibromochloromethane	0.50 U	--	1.0 U	-	-	0.50 U	-	0.50 U
1,2-Dichloroethane	0.50 U	--	1.0 U	-	-	0.50 U	-	0.50 U
1,3 Chlorobenzene	--	--	--	-	-	--	-	--
1,1-Dichloroethane	0.50 U	--	1.0 U	-	-	0.50 U	-	0.50 U
cis-1,2-Dichloroethene	0.50 U	--	1.0 U	-	-	0.50 U	-	0.50 U
trans-1,2-Dichloroethene	0.50 U	--	1.0 U	-	-	0.50 U	-	0.50 U
1,1-Dichloroethene	0.50 U	--	1.0 U	-	-	0.50 U	-	0.50 U
1,2-Dichloroethene (total)	--	--	--	--	--	--	--	--
1,2-Dichlorobenzene	0.50 U	--	1.0 U	-	-	0.50 U	-	0.50 U
1,3-Dichlorobenzene	0.50 U	--	1.0 U	-	-	0.50 U	-	0.50 U
1,4-Dichlorobenzene	0.50 U	--	1.0 U	-	-	0.50 U	-	0.50 U
Chloroethane	0.50 U	--	1.0 U	-	-	0.50 U	-	0.50 U
Chloromethane	0.50 U	--	1.0 U	-	-	0.50 U	-	0.50 U
Tetrachloroethene	5.4	--	3.6	-	-	2.7	-	2.1
1,1,1-Trichloroethane	0.50 U	--	1.0 U	-	-	0.50 U	-	0.50 U
Trichloroethene	0.50 U	--	1.0 U	-	-	0.50 U	-	0.50 U
Vinyl Chloride	0.50 U	--	1.0 U	-	-	0.50 U	-	0.50 U
1,2,4-Trichlorobenzene	0.50 UJ	--	1.0 U	-	-	0.50 U	-	0.50 U
cis-1,3-Dichloropropene	0.50 U	--	1.0 U	-	-	0.50 U	-	0.50 U
Methylene Chloride	5.0 U	--	1.0 U	-	-	0.50 U	-	0.50 U
Trichlorofluoromethane	0.50 U	--	1.0 U	--	--	0.50 U	--	0.50 U
***Semi-Volatiles* (µg/l)**								
Bis(2-chloroethyl)Ether	4.9 U	--	0.10 U	--	--	0.096 U	--	0.10 U
1,4-Dioxane	--	--	--	--	--	2.0 U	--	2.0 U
Bis(2-ethylhexyl)phthalate	4.9 U	--	5.0 U	--	--	4.9 U	--	20
2,2'-oxybis (1-Chloropropane)	4.9 U	--	5.0 U	--	--	9.8 U	--	9.5 U
2,4-Dimethylphenol	4.9 U	--	5.0 U	--	--	4.9 U	--	4.8 U
2-Methylnaphthalene	4.9 U	--	5.0 U	--	--	4.9 U	--	4.8 U
2-Methylphenol	4.9 U	--	5.0 U	--	--	9.8 U	--	9.5 U
4-Methylphenol	4.9 U	--	5.0 U	--	--	9.8 U	--	9.5 U
Acetophenone	4.9 U	--	5.0 U	--	--	9.8 U	--	9.5 U
Caprolactam	4.9 UJ	--	5.0 U	--	--	9.8 U	--	9.5 U
Diethylphthalate	4.9 U	--	5.0 U	--	--	4.9 U	--	4.8 U
N-Nitrosodiphenylamine	4.9 U	--	5.0 U	--	--	4.9 U	--	4.8 U
Naphthalene	4.9 U	--	5.0 U	--	--	4.9 U	--	4.8 U
Phenol	4.9 U	--	5.0 U	--	--	9.8 U	--	9.5 U
***Inorganics* (mg/l)**								
Dissolved Manganese	0.0022 J	0.0018 J	0.0016 J	0.0039 J	0.0076 J	0.0089 J	0.0054 J	0.0202
Dissolved Iron	0.1 U	0.100 U	0.100 U	0.026 J	0.100 U	0.100 U	0.100 U	0.100 U
Dissolved Lead	--	--	--	--	--	--	--	--
Dissolved Cobalt	--	0.0500 U	0.0500 U	0.0050 U	0.00034 J	0.050 U	0.050 U	0.0011 J
Biological Oxygen Demand (mg/l)	--	--	--	--	--	--	--	--
Field Parameters								
Temperature (Degrees Celcius)	14.7	15.0	16.2	17.6	15.6	13.6	14.5	14.4
Conductivity (µs/cm)	303	323	371	226	229	266	273	214
pH (standard units)	6.59	7.07	7.00	6.19	5.95	5.74	5.72	5.66
Dissolved Oxygen (mg/l)	3.22	3.11	2.68	2.92	3.31	2.65	3.80	2.96
ORP (mV)	134	94	206	182	176	224	190	241
Water-Level Elevation (ft, MSL)	-11.89	-14.02	-14.50	-12.97	-12.75	-19.13	-14.48	-17.84

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NP - Well not pumping
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B - Analyte Detected in Method Blank
R - Data Rejected

Attachment Table 1-1 (continued)

Historical Summary of Groundwater Quality Data Collected by New Castle County for the Vicinity of the Army Creek and Delaware Sand & Gravel Landfills

Parameter	MW-38N		
	4/10	10/15	3/16
Non-Halogenated VOCs **(µg/l)**			
Benzene	--	--	--
Toluene	--	--	--
Ethylbenzene	--	--	--
Xylene (total)	--	--	--
2-Butanone	--	--	--
Acetone	--	--	--
Carbon Disulfide	--	--	--
Cyclohexane	--	--	--
Isopropylbenzene	--	--	--
Methy-tert-butyl ether	--	--	--
Methylcyclohexane	--	--	--
Styrene	--	--	--
4-Methyl-2-pentanone	--	--	--
Halogenated VOCs **(µg/l)**			
Bromoform	--	--	--
Bromodichloromethane	--	--	--
Carbon Tetrachloride	--	--	--
Chlorobenzene	--	--	--
Chloroform	--	--	--
Dibromochloromethane	--	--	--
1,2-Dichloroethane	--	--	--
1,3 Chlorobenzene	--	--	--
1,1-Dichloroethane	--	--	--
cis-1,2-Dichloroethene	--	--	--
trans-1,2-dischloroethene	--	--	--
1,1-Dichloroethene	--	--	--
1,2-Dichloroethene (total)	--	--	--
1,2-Dichlorobenzene	--	--	--
1,3-Dichlorobenzene	--	--	--
1,4-Dichlorobenzene	--	--	--
Chloroethane	--	--	--
Tetrachloroethene	--	--	--
1,1,1-Trichloroethane	--	--	--
1,1,2-Trichloroethane	--	--	--
1,1,2,2-Tetrachloroethane	--	--	--
Trichloroethene	--	--	--
Vinyl Chloride	--	--	--
1,2,4-Trichlorobenzene	--	--	--
cis-1,3-Dichloropropene	--	--	--
Methylene Chloride	--	--	--
Trichlorofluoromethane	--	--	--
Semi-Volatiles **(µg/l)**			
Bis(2-chloroethyl)Ether	--	--	--
Bis(2-ethylhexyl)phthalate	--	--	--
2,2'-oxybis (1-Chloropropane)	--	--	--
2,4-Dimethylphenol	--	--	--
2-Methylnaphthalene	--	--	--
2-Methylphenol	--	--	--
4-Methylphenol	--	--	--
Acetophenone	--	--	--
Caprolactam	--	--	--
Diethylphthalate	--	--	--
Dimethylphthalate	--	--	--
N-Nitrosodiphenylamine	--	--	--
Naphthalene	--	--	--
1,1'- Biphenyl	--	--	--
Di (n-butyl) phthalate	--	--	--
2,4-Dichlorophenol	--	--	--
bis (2-chloroethoxy)methane	--	--	--
Di-n-octylphthalate	--	--	--
Phenol	--	--	--
Inorganics (mg/l)			
Dissolved Manganese	--	0.0381	0.031
Dissolved Iron	--	0.107	0.30
Dissolved Lead	0.010 U	--	--
Dissolved Cobalt	--	0.0021 J	0.0029 J
Biological Oxygen Demand (mg/l)	--	--	--
Field Parameters			
Temperature (Degrees Celcius)	13.7	13.8	13.2
Conductivity (µs/cm)	366	267	284
pH (standard units)	5.63	5.85	5.84
Dissolved Oxygen (mg/l)	0.00	3.22	4.64
ORP (mV)	115	225	252
Water-Level Elevation (ft. MSL)	-5.50	-10.08	-7.71

-- Not analyzed or data not available to RAI as of November 29, 2016
U - Analyte was not detected above the reporting limit
J - Estimated concentration.
B - Analyte Detected in Method Blank

Attachment Table 1-1 (continued)

Historical Summary of Groundwater Quality Data Collected by New Castle County for the Vicinity of the Army Creek and Delaware Sand & Gravel Landfills

Parameter	MW-49N																	
	7/00	1/01	4/01	7/01	10/01	1/02	4/02	7/02	10/02	1/03	4/03	7/03	10/04	1/05	4/05	7/05	10/05	1/06
Non-Halogenated VOCs **(µg/l)**																		
Benzene	--	--	1 U	1 U	--	--	--	--	--	--	5 U	0.5 U	0.5 U	5 U	5 U	5 U	5 UJ	10 U
Toluene	--	--	1 U	1 U	--	--	--	--	--	--	5 U	0.5 U	0.5 U	5 U	5 U	5 U	5 UJ	10 U
Ethylbenzene	--	--	1 U	1 U	--	--	--	--	--	--	5 U	0.5 U	0.5 U	5 U	5 U	5 U	5 UJ	10 U
Xylene (total)	--	--	1 U	1 U	--	--	--	--	--	--	5 U	0.27 JB	0.5 U	5 U	5 U	5 U	5 U	10 U
2-Butanone	--	--	--	--	--	--	--	--	--	--	--	--	5 U	10 R	10 U	10 R	10 UJ	10 U
Acetone	--	--	--	--	--	--	--	--	--	--	--	--	5 UJ	20 R	20 U	20 R	20 R	10 U
Carbon Disulfide	--	--	--	--	--	--	--	--	--	--	--	--	0.5 U	5 U	5 U	5 U	5 UJ	10 U
Cyclohexane	--	--	--	--	--	--	--	--	--	--	--	--	0.5 U	--	--	--	--	10 U
Isopropylbenzene	--	--	--	--	--	--	--	--	--	--	--	--	0.5 U	--	--	--	--	10 U
Methy tert-butyl ether	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	10 U
Methylcyclohexane	--	--	--	--	--	--	--	--	--	--	--	--	0.5 U	--	--	--	--	10 U
4-Methyl-2-pentanone	--	--	--	--	--	--	--	--	--	--	--	--	5 U	10 U	10 U	10 U	10 UJ	10 U
Halogenated VOCs **(µg/l)**																		
Bromoform	--	--	1 U	1 U	--	--	--	--	--	--	5 U	0.5 U	0.14 J	5 U	5 U	5 U	5 UJ	10 UJ
Bromodichloromethane	--	--	1 U	1 U	--	--	--	--	--	--	5 U	0.5 U	0.5 U	5 U	5 U	5 U	5 UJ	10 U
Carbon Tetrachloride	--	--	1 UJ	1 U	--	--	--	--	--	--	5 U	0.5 U	0.5 U	5 U	5 U	5 U	5 UJ	10 UJ
Chlorobenzene	--	--	1 U	1 U	--	--	--	--	--	--	5 U	0.5 U	0.5 U	5 U	5 U	5 U	5 UJ	10 U
Chloroform	--	--	0.6 J	0.8 J	--	--	--	--	--	--	5 U	0.5 U	0.3 J	5 U	5 U	5 U	5 UJ	10 U
Dibromochloromethane	--	--	1 U	1 U	--	--	--	--	--	--	5 U	0.5 U	0.5 U	5 U	5 U	5 U	5 UJ	10 U
1,2-Dichloroethane	--	--	5	0.8 J	--	--	--	--	--	--	5 U	0.5 U	1.1	5 U	5 U	5 U	5 UJ	10 U
1,3 Chlorobenzene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1,1-Dichloroethane	--	--	1 U	1 U	--	--	--	--	--	--	5 U	0.5 U	0.61	5 U	5 U	5 U	5 UJ	10 U
cis-1,2-Dichloroethene	--	--	0.1 J	0.1 J	--	--	--	--	--	--	5 U	0.11 J	0.22 J	5 U	5 U	5 U	5 UJ	10 U
trans-1,2-Dichloroethene	--	--	--	--	--	--	--	--	--	--	--	--	0.11 J	5 U	5 U	5 U	5 UJ	10 U
1,1-Dichloroethene	--	--	1 U	1 U	--	--	--	--	--	--	5 U	0.5 U	0.5 U	--	--	--	--	10 U
1,2-Dichloroethene (total)	--	--	2 U	2 U	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1,2-Dichlorobenzene	--	--	1 U	1 U	--	--	--	--	--	--	5 U	0.5 U	0.12 J	--	--	--	--	10 U
1,3-Dichlorobenzene	--	--	1 U	1 U	--	--	--	--	--	--	5 U	0.5 U	0.5 U	--	--	--	--	10 U
1,4-Dichlorobenzene	--	--	1 U	1 U	--	--	--	--	--	--	5 U	0.5 U	0.99	--	--	--	--	10 U
Chloroethane	--	--	1 U	1 U	--	--	--	--	--	--	5 U	0.5 U	0.5 U	5 U	5 U	5 U	5 UJ	10 U
Chloromethane	--	--	1 U	1 U	--	--	--	--	--	--	5 U	0.5 U	0.5 U	5 U	5 U	5 U	5 u	10 U
Tetrachloroethene	--	--	0.2 J	1 U	--	--	--	--	--	--	5 U	0.5 U	0.41 J	5 U	5 U	5 U	5 UJ	10 U
1,1,1-Trichloroethane	--	--	1 U	1 U	--	--	--	--	--	--	5 U	0.5 U	0.5 U	5 U	5 U	5 U	5 UJ	10 U
Trichloroethene	--	--	0.3 J	0.3 J	--	--	--	--	--	--	0.7 J	0.5 U	0.41 J	5 U	5 U	5 U	5 UJ	10 U
Vinyl Chloride	--	--	1 U	1 U	--	--	--	--	--	--	5 U	0.5 U	0.5 U	5 U	5 U	5 U	5 UJ	10 U
1,2,4-Trichlorobenzene	--	--	--	--	--	--	--	--	--	--	--	--	0.5 U	--	--	--	--	10 U
cis-1,3-Dichloropropene	--	--	--	--	--	--	--	--	--	--	--	--	0.5 U	5 U	5 U	5 U	5 UJ	10 U
Methylene Chloride	--	--	--	--	--	--	--	--	--	--	--	--	0.5 U	5 U	5 U	5 U	5 UJ	10 U
Trichlorofluoromethane	--	--	--	--	--	--	--	--	--	--	--	--	3	--	--	--	--	18
Semi-Volatiles **(µg/l)**																		
Bis(2-chloroethyl)Ether	0.05 U	0.018 J	0.7 J	0.026 U	0.025 U	0.024 U	1.7	0.032 J	0.05 U	0.04 J	0.037 J	0.05 U	0.87	0.032 B	0.017 U	0.021 U	0.02 UL	0.019 U
Bis(2-ethylhexyl)phthalate	--	--	--	--	--	--	--	--	--	--	--	--	17	5 U	5 U	5.1 UL	8.2	5.2 U
Benzo (a) Anthracene	--	--	--	--	--	--	--	--	--	--	--	--	5 U	5 U	5 U	5.1 U	5 U	5 U
Benzo (a) Pyrene	--	--	--	--	--	--	--	--	--	--	--	--	5 U	5 U	5 U	5.1 U	5 U	5 U
Benzo (b) Fluoranthene	--	--	--	--	--	--	--	--	--	--	--	--	5 U	5 U	5 U	5.1 U	5 U	5 U
Benzo (k) Fluoranthene	--	--	--	--	--	--	--	--	--	--	--	--	5 U	5 U	5 U	5.1 U	5 U	5 U
Benzo (g,h,i) Perylene	--	--	--	--	--	--	--	--	--	--	--	--	5 U	5 U	5 U	5.1 U	5 U	5 U
Chrysene	--	--	--	--	--	--	--	--	--	--	--	--	5 U	5 U	5 U	5.1 U	5 U	5 U
Indeno (1,2,3-cd) Pyrene	--	--	--	--	--	--	--	--	--	--	--	--	5 U	5 U	5 U	5.1 U	5 U	5 U
2,2'-oxybis (1-Chloropropane)	--	--	--	--	--	--	--	--	--	--	--	--	5 UJ	5 U	5 U	5.1 U	5 U	5 UL
2,4-Dimethylphenol	--	--	--	--	--	--	--	--	--	--	--	--	5 U	5 U	5 U	5.1 U	5 UL	5 U
2-Methylnaphthalene	--	--	--	--	--	--	--	--	--	--	--	--	5 U	5 U	5 U	5.1 UL	5 U	5 U
2-Methylphenol	--	--	--	--	--	--	--	--	--	--	--	--	5 U	5 U	5 U	5.1 U	5 UL	5 U
4-Methylphenol	--	--	--	--	--	--	--	--	--	--	--	--	5 U	5 U	5 U	5.1 U	5 UL	5 U
Acetophenone	--	--	--	--	--	--	--	--	--	--	--	--	5 U	5 U	5 U	5.1 U	5 U	5 U
Caprolactam	--	--	--	--	--	--	--	--	--	--	--	--	5 U	5 U	5 U	5.1 UL	5 U	5 UL
Diethylphthalate	--	--	--	--	--	--	--	--	--	--	--	--	5 U	5 U	5 U	5.1 UL	5 U	5 U
N-Nitrosodiphenylamine	--	--	--	--	--	--	--	--	--	--	--	--	5 U	5 U	5 UJ	5.1 U	5 U	5 U
Naphthalene	--	--	--	--	--	--	--	--	--	--	--	--	5 U	5 U	5 U	5.1 UL	5 U	5 U
Phenol	--	--	--	--	--	--	--	--	--	--	--	--	5 U	5 U	5 U	5.1 U	5 U	5 U
Phenanthrene	--	--	--	--	--	--	--	--	--	--	--	--	5 U	5 U	5 U	5.1 U	5 U	5 U
Di-n-octylphthalate	--	--	--	--	--	--	--	--	--	--	--	--	5 U	5 U	5 U	5.1 U	5 U	5 U
Pyrene	--	--	--	--	--	--	--	--	--	--	--	--	5 U	5 U	5 U	5.1 U	5 U	5 U
Fluoranthene	--	--	--	--	--	--	--	--	--	--	--	--	5 U	5 U	5 U	5.1 U	5 U	5 U
Inorganics **(mg/l)**																		
Dissolved Manganese	--	--	--	--	--	--	--	--	--	--	--	0.0041 B	0.0973	0.0023 B	0.0026	0.0048	0.942	0.0002 U
Dissolved Iron	--	--	0.0188 B	0.011 U	--	--	--	--	--	--	0.0142 U	0.0244 U	0.011 U	0.0524 B	0.0273 U	0.028 U	0.0131 U	0.0153 U
Lead	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Biological Oxygen Demand (mg/l)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.0	2.3	2.3	< 1
Field Parameters																		
Temperature (Degrees Celcius)	13.14	13.45	12.81	13.4	--	13.4	15.01	14.53	16.47	14.57	14.84	17.49	13.66	13.41	13.03	14.73	13.60	13.5
Conductivity (µs/cm)	0.087	0.081	70.57	87.16	--	88	137.1	77.92	46.02	82	71.72	78.05	146	42	57	56	134	68
pH (standard units)	5.59	6.45	5.55	5.05	--	5.26	5.34	4.13	5.31	5.41	4.49	4.98	5.53	5.57	5.13	4.19	5.94	4.75
Dissolved Oxygen (mg/l)	--	1.64	1.18	0.59	--	4.22	0.72	0.75	2.6	2.49	3.12	1.71	0.31	3.84	4.43	2.97	1.37	0.99
ORP (mV)	219.2	241.9	435	281.7	--	347.1	353.2	344.8	309.2	263.8	261.4	73.1	164.3	220.8	249.4	249.4	115.3	249
Water-Level Elevation (ft, MSL)	-30.05	-27.69	-23.20	-29.17	-32.73	-31.32	-28.04	-37.43	-36.04	-33.66	-29.73	-33.83	-24.64	-18.99	-3.46	-16.64	-18.41	-3.69

-- Not analyzed or data not available to RAI as of November 29, 2016
U - Analyte was not detected above the reporting limit
J - Estimated concentration.
K - Analyte present, reported value may be biased high.
L - Analyte present, reported value may be biased low.
UL - Not detected, quantitation limit is probably higher

R - Data Rejected
D - Sample diluted in the lab for analysis.
NP - Well not pumping
P - Discrepency in GC analysis. Lower value reported
B - Analyte Detected in Method Blank

Attachment Table 1-1 (continued)

Historical Summary of Groundwater Quality Data Collected by New Castle County for the Vicinity of the Army Creek and Delaware Sand & Gravel Landfills

Parameter	MW-49N																
	4/06	7/06	10/06	1/07	4/07	7/07	10/07	1/08	4/08	7/08	10/08	1/09	4/09	10/09	10/10	10/11	10/12
Non-Halogenated VOCs **(µg/l)**																	
Benzene	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Toluene	1.7	1 U	0.64 J	0.78 J	1 U	0.48 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Ethylbenzene	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Xylene (total)	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U
2-Butanone	2.2 J	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 UJ	5 U	5 U	5 U	5 U	5 U
Acetone	10 J	9.3 U	5 U	2.9 U	5 U	5 U	4.4 J	5 U	5 U	5 U	5 U	5 UJ	5 UJ	3.1 U	5 U	5 U	5 U
Carbon Disulfide	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 UJ	1 U	1 U	1 U	1 U	1 U	1 U
Cyclohexane	1 U	1 U	1 U	1 U	1 UJ	1 U	1 U	1 U	1 U	1 U	1 U	1 UJ	1 U	1 U	1 U	1 U	1 U
Isopropylbenzene	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Methy tert-butyl ether	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	0.77 J	1 U	1 U	1 U	1 U
Methylcyclohexane	1 U	1 U	1 U	1 U	1 UJ	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
4-Methyl-2-pentanone	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 UJ	5 UJ	5 U	5 U	5 U	5 U	5 U
Halogenated VOCs **(µg/l)**																	
Bromoform	1 U	1 U	1 U	1 U	1 U	1 UJ	1 U	1 UJ	1 UJ	1 U	1 U	1 U	1 UJ	1 U	1 U	1 U	1 U
Bromodichloromethane	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Carbon Tetrachloride	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 UJ	1 UJ	1 U	1 U	1 U	1 U	1 U	1 U	1 UJ	1 U
Chlorobenzene	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Chloroform	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Dibromochloromethane	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,2-Dichloroethane	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,3 Chlorobenzene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1,1-Dichloroethane	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
cis-1,2-Dichloroethene	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	0.43 J	0.42 J	0.34 J	0.74 J	1 U	0.49 J	0.41 J	0.50 J	0.27 J
trans-1,2-Dichloroethene	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,1-Dichloroethene	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,2-Dichloroethene (total)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1,2-Dichlorobenzene	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,3-Dichlorobenzene	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,4-Dichlorobenzene	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Chloroethane	1 R	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Chloromethane	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	0.14 J	1 U	1 UJ	1 U	1 U	1 UJ	1 U	1 U	1 U
Tetrachloroethene	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	0.51 J	1 U	1 U	1 U	1 U
1,1,1-Trichloroethane	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Trichloroethene	1 U	1 U	1 U	1 U	1 U	0.24 J	0.22 J	1 U	0.86 J	1 U	0.83 J	1.4	1 U	1.6	1.1	0.96 J	0.70 J
Vinyl Chloride	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,2,4-Trichlorobenzene	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
cis-1,3-Dichloropropene	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Methylene Chloride	1 U	1 UJ	1 U	1 U	1 U	1 UJ	1 UJ	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Trichlorofluoromethane	1 UJ	1 U	1 U	1 U	2.8 J	3.1	2.3	1.6	9.3	8.5	7.1	12	1 U	12	11	8.2	6.5
Semi-Volatiles **(µg/l)**																	
Bis(2-chloroethyl)Ether	0.018 U	0.019 U	0.059	0.018 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.021 U	0.020 U	0.020 U	5.0 U	5.0 U	5.0 U	5.0 U
Bis(2-ethylhexyl)phthalate	5 UL	5 U	5 U	5 U	21 J	5 UL	5 UL	5 U	5 UL	5 U	5.1 U	5.0 UJ	5.3 U	5.0 UJ	5.0 U	13	5.0 U
Benzo (a) Anthracene	5 U	5 U	5 U	5 U	1.3 J	5 U	5 U	5 U	5 U	5 U	5.1 U	5.0 U	5.3 U	5.0 U	5.0 U	5.0 U	5.0 U
Benzo (a) Pyrene	5 U	5 U	5 U	5 U	2.4 L	5 UL	5 UL	5 UL	5 UL	5 UL	5.1 U	5.0 U	5.3 U	5.0 U	5.0 U	5.0 U	5.0 U
Benzo (b) Fluoranthene	5 U	5 U	5 U	5 U	5.3 L	5 UL	5 UL	5 UL	5 UL	5 UL	5.1 U	5.0 U	5.3 U	5.0 U	5.0 U	5.0 U	5.0 U
Benzo (k) Fluoranthene	5 U	5 U	5 U	5 U	2.8 L	5 UL	5 UL	5 UL	5 UL	5 UL	5.1 U	5.0 U	5.3 U	5.0 U	5.0 U	5.0 U	5.0 U
Benzo (g,h,i) Perylene	5 U	5 U	5 U	5 U	3.5 L	5 UL	5 UL	5 UL	5 UL	5 UL	5.1 U	5.0 U	5.3 U	5.0 U	5.0 U	5.0 U	5.0 U
Chrysene	5 U	5 U	5 U	5 U	4.4 J	5 U	5 U	5 U	5 U	5 U	5.1 U	5.0 U	5.3 U	5.0 U	5.0 U	5.0 U	5.0 U
Indeno (1,2,3-cd) Pyrene	5 U	5 U	5 U	5 U	3.3 L	5 UL	5 UL	5 UL	5 UL	5 UL	5.1 U	5.0 UJ	5.3 U	5.0 U	5.0 U	5.0 U	5.0 U
2,2'-oxybis (1-Chloropropane)	5 U	5 U	5 U	5 U	5 U	5 UL	5 U	5 U	5 U	5 U	5.1 U	5.0 U	5.3 U	5.0 U	5.0 U	5.0 U	5.0 U
2,4-Dimethylphenol	5 U	5 U	5 U	5 U	5 U	5 UL	5 U	5 U	5 U	5 U	5.1 U	5.0 U	5.3 U	5.0 U	5.0 U	5.0 U	5.0 U
2-Methylnaphthalene	5 U	5 U	5 U	5 U	5 U	5 UL	5 U	5 U	5 U	5 U	5.1 U	5.0 U	5.3 U	5.0 U	5.0 U	5.0 U	5.0 U
2-Methylphenol	5 U	5 U	5 U	5 U	5 U	5 UL	5 U	5 U	5 U	5 U	5.1 U	5.0 U	5.3 U	5.0 U	5.0 U	5.0 U	5.0 U
4-Methylphenol	5 U	5 U	5 U	5 U	5 U	5 UL	5 U	5 U	5 U	5 U	5.1 U	5.0 U	5.3 U	5.0 U	5.0 U	5.0 U	5.0 U
Acetophenone	5 U	5 U	5 U	5 U	5 U	5 UL	5 U	5 U	5 U	5 U	5.1 U	5.0 U	5.3 U	5.0 U	5.0 U	5.0 U	5.0 U
Caprolactam	5 UL	5 U	5 U	5 U	5 U	5 UL	5 UL	5 UJ	5 UL	5 U	5.1 UJ	5.0 U	5.3 R	5.0 U	5.0 U	5.0 U	5.0 U
Diethylphthalate	5 U	5 U	5 U	5 U	5 U	5 UL	5 UL	5 U	5 UL	5 U	5.1 U	5.0 U	5.3 U	5.0 U	5.0 U	5.0 U	5.0 U
N-Nitrosodiphenylamine	5 U	5 U	5 U	5 U	5 U	5 UL	5 U	5 U	5 U	5 U	5.1 U	5.0 U	5.3 U	5.0 U	5.0 U	5.0 U	5.0 U
Naphthalene	5 U	5 U	5 U	5 U	5 U	5 UL	5 U	5 U	5 U	5 U	5.1 U	5.0 U	5.3 U	5.0 U	5.0 U	5.0 U	5.0 U
Phenol	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5.1 U	5.0 U	5.3 U	5.0 U	5.0 U	5.0 U	5.0 U
Phenanthrene	5 U	5 U	5 U	5 U	1.8 J	5 UL	5 U	5 U	5 UL	5 U	5.1 U	5.0 U	5.3 U	5.0 U	5.0 U	5.0 U	5.0 U
Di-n-octylphthalate	5 U	5 U	5 U	2.4 J	5 U	5 UL	5 UL	5 U	5 UL	5 U	5.1 U	5.0 U	5.3 U	5.0 U	5.0 U	5.0 U	5.0 U
Pyrene	5 U	5 U	5 U	5 U	6.0	5 U	5 U	5 U	5 U	5 U	5.1 U	5.0 U	5.3 U	5.0 U	5.0 U	5.0 U	5.0 U
Fluoranthene	1.4 J	5 U	5 U	5 U	8.5	5 U	1.5 J	5 U	5 U	5 U	5.1 U	5.0 U	5.3 U	5.0 U	5.0 U	5.0 U	5.0 U
Inorganics **(mg/l)**																	
Dissolved Manganese	0.0082 U	0.00029 U	0.0013 U	0.00051 U	0.0012 U	0.0089	0.0129	0.0009	0.0026	0.0012	0.0016 U	0.0016 J	0.00066 U	0.0021 J	0.015 U	0.0021 J	0.0150 U
Dissolved Iron	0.0101 U	0.0124 U	0.0116 U	0.0458 U	0.0327 U	0.0988	0.009 U	0.155 U	0.0419 U	0.0126 U	0.0207 U	0.0246 U	0.0611 U	0.1 U	0.1 U	0.100 U	0.1 U
Dissolved Cobalt	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dissolved Lead	--	--	--	--	--	--	--	--	--	--	--	--	--	0.010 U	0.010 U	0.010 U	0.0100 U
Biological Oxygen Demand (mg/l)	< 2	< 2	< 2	--	--	--	--	1	--	--	--	--	--	--	--	--	--
Field Parameters																	
Temperature (Degrees Celcius)	15.3	18.2	17.3	15.1	15.7	17.6	16.0	14.0	16.1	16.1	15.9	13.0	15.6	15.3	14.6	16.6	14.7
Conductivity (µs/cm)	33	12	25	10	48	69	51	63	79	67	58	67	104	98	66	78	101
pH (standard units)	6.19	6.32	6.42	6.52	6.04	5.55	5.98	7.85	5.41	4.64	5.53	6.26	5.45	6.00	5.39	5.63	5.55
Dissolved Oxygen (mg/l)	6.01	5.07	4.73	7.24	6.06	0.95	0.00	2.04	4.38	4.41	3.47	4.31	3.91	4.03	3.64	3.21	4.03
ORP (mV)	202	94	109	77	99	61	102	141	180	239	234	291	218	240	206	224	237
Water-Level Elevation (ft, MSL)	-11.65	-17.96	-16.12	-14.45	-16.69	-19.51	-21.19	-16.06	-16.90	-21.53	-17.32	-15.14	-12.52	-17.00	-12.92	-16.46	-9.96

-- Not analyzed or data not available to RAI as of November 29, 2016
U - Analyte was not detected above the reporting limit
J - Estimated concentration.
K - Analyte present, reported value may be biased high.
L - Analyte present, reported value may be biased low.
UL - Not detected, quantitation limit is probably higher

R - Data Rejected
D - Sample diluted in the lab for analysis.
NP - Well not pumping
P - Discrepency in GC analysis. Lower value reported
B - Analyte Detected in Method Blank

Attachment Table 1-1 (continued)

Summary of Groundwater Quality Data Collected by New Castle County for the Vicinity of the Army Creek and Delaware Sand & Grav

Parameter	MW-49N						
	4/15	10/15	3/16	4/16	10/16	4/17	10/17
Non-Halogenated VOCs **(µg/l)**							
Benzene	--	--	--	--	--	--	--
Toluene	--	--	--	--	--	--	--
Ethylbenzene	--	--	--	--	--	--	--
Xylene (total)	--	--	--	--	--	--	--
2-Butanone	--	--	--	--	--	--	--
Acetone	--	--	--	--	--	--	--
Carbon Disulfide	--	--	--	--	--	--	--
Cyclohexane	--	--	--	--	--	--	--
Isopropylbenzene	--	--	--	--	--	--	--
Methy tert-butyl ether	--	--	--	--	--	--	--
Methylcyclohexane	--	--	--	--	--	--	--
4-Methyl-2-pentanone	--	--	--	--	--	--	--
Halogenated VOCs **(µg/l)**							
Bromoform	--	--	--	--	--	--	--
Bromodichloromethane	--	--	--	--	--	--	--
Carbon Tetrachloride	--	--	--	--	--	--	--
Chlorobenzene	--	--	--	--	--	--	--
Chloroform	--	--	--	--	--	--	--
Dibromochloromethane	--	--	--	--	--	--	--
1,2-Dichloroethane	--	--	--	--	--	--	--
1,3 Chlorobenzene	--	--	--	--	--	--	--
1,1-Dichloroethane	--	--	--	--	--	--	--
cis-1,2-Dichloroethene	--	--	--	--	--	--	--
trans-1,2-Dichloroethene	--	--	--	--	--	--	--
1,1-Dichloroethene	--	--	--	--	--	--	--
1,2-Dichloroethene (total)	--	--	--	--	--	--	--
1,2-Dichlorobenzene	--	--	--	--	--	--	--
1,3-Dichlorobenzene	--	--	--	--	--	--	--
1,4-Dichlorobenzene	--	--	--	--	--	--	--
Chloroethane	--	--	--	--	--	--	--
Chloromethane	--	--	--	--	--	--	--
Tetrachloroethene	--	--	--	--	--	--	--
1,1,1-Trichloroethane	--	--	--	--	--	--	--
Trichloroethene	--	--	--	--	--	--	--
Vinyl Chloride	--	--	--	--	--	--	--
1,2,4-Trichlorobenzene	--	--	--	--	--	--	--
cis-1,3-Dichloropropene	--	--	--	--	--	--	--
Methylene Chloride	--	--	--	--	--	--	--
Trichlorofluoromethane	--	--	--	--	--	--	--
Semi-Volatiles **(µg/l)**							
Bis(2-chloroethyl)Ether	--	--	--	--	--	--	--
Bis(2-ethylhexyl)phthalate	--	--	--	--	--	--	--
Benzo (a) Anthracene	--	--	--	--	--	--	--
Benzo (a) Pyrene	--	--	--	--	--	--	--
Benzo (b) Fluoranthene	--	--	--	--	--	--	--
Benzo (k) Fluoranthene	--	--	--	--	--	--	--
Benzo (g,h,i) Perylene	--	--	--	--	--	--	--
Chrysene	--	--	--	--	--	--	--
Indeno (1,2,3-cd) Pyrene	--	--	--	--	--	--	--
2,2'-oxybis (1-Chloropropane)	--	--	--	--	--	--	--
2,4-Dimethylphenol	--	--	--	--	--	--	--
2-Methylnaphthalene	--	--	--	--	--	--	--
2-Methylphenol	--	--	--	--	--	--	--
4-Methylphenol	--	--	--	--	--	--	--
Acetophenone	--	--	--	--	--	--	--
Caprolactam	--	--	--	--	--	--	--
Diethylphthalate	--	--	--	--	--	--	--
N-Nitrosodiphenylamine	--	--	--	--	--	--	--
Naphthalene	--	--	--	--	--	--	--
Phenol	--	--	--	--	--	--	--
Phenanthrene	--	--	--	--	--	--	--
Di-n-octylphthalate	--	--	--	--	--	--	--
Pyrene	--	--	--	--	--	--	--
Fluoranthene	--	--	--	--	--	--	--
Inorganics **(mg/l)**							
Dissolved Manganese	0.0115 J	0.0150 U	0.0050 U	0.0015 J	0.0051 J	0.0017 J	0.0029 J
Dissolved Iron	0.0794 J	0.100 U	0.53	0.100 U	0.100 U	0.100 U	0.16
Dissolved Cobalt	0.0500 U	0.0500 U	0.0050 U	0.0031 J	0.00020 J	0.0035 J	0.0027 J
Dissolved Lead	--	--	--	--	--	--	--
Biological Oxygen Demand (mg/l)	--	--	--	--	--	--	--
Field Parameters							
Temperature (Degrees Celcius)	15.7	14.9	17.6	18.5	14.0	14.6	15.3
Conductivity (µs/cm)	66	69	97	199	245	119	106
pH (standard units)	6.37	6.85	6.16	5.77	5.55	5.55	5.66
Dissolved Oxygen (mg/l)	4.32	0.51	3.38	4.21	4.14	3.71	3.98
ORP (mV)	153	178	202	91	228	200	268
Water-Level Elevation (ft, MSL)	-14.32	-15.01	-12.83	-12.59	-19.74	-14.67	-14.67

-- Not analyzed or data not available to RAI as of November 29, 2016
U - Analyte was not detected above the reporting limit
J - Estimated concentration.
K - Analyte present, reported value may be biased high.
L - Analyte present, reported value may be biased low.
UL - Not detected, quantitation limit is probably higher

R - Data Rejected
D - Sample diluted in the lab for analysis.
NP - Well not pumping
P - Discrepency in GC analysis. Lower value reporte
B - Analyte Detected in Method Blank

ATTACHMENT 2

PFAS GROUNDWATER MONITORING RESULTS COLLECTED BY GOLDER
OCTOBER 2016 + APRIL 2017

Attachment Table 2-1
September-October 2016 Semi-Annual Monitoring Program - Summary of Detected PFCs
Delaware Sand & Gravel Superfund Site
New Castle, Delaware

			Sample ID	DDA-05			DDA-01			DDA-02			DDA-03			DDA-07-US			DDA-10-US			DDA-11-LS			DDA-11-US			DDA-12-US			DDA-15-US			DGC-8S			DGC-8D			DGC-10D			DGC-10S		
			Sample Date	9/27/2016			9/27/2016			9/28/2016			9/29/2016			10/10/2016			10/5/2016			9/27/2016			9/27/2016			9/29/2016			10/6/2016			10/6/2016			10/6/2016			9/29/2016			9/29/2016		
			N=Normal, FD=Field Duplicate	N			N			N			N			N			N			N			N			N			N			N			N			N			N		
Parameter	Unit	CAS	HA	Result	Qual	RDL	Result	Qual	RDL	Result	Qual	RDL	Result	Qual	RDL	Result	Qual	RDL	Result	Qual	RDL	Result	Qual	RDL	Result	Qual	RDL	Result	Qual	RDL	Result	Qual	RDL	Result	Qual	RDL	Result	Qual	RDL	Result	Qual	RDL	Result	Qual	RDL
Perfluorohexanoic acid	ng/l	307-24-4	NE	29	J-	1	29		1	25		1	61		1	25		1	43	J	1	25		1	27		1	60		1	21		1	31	J-	1	13		1	21		1	20		1
Perfluoroheptanoic acid	ng/l	375-85-9	NE	13		1	22		1	22	J-	1	48	J-	1	16		1	23	J	1	20	J+	1	23		1	34		1	17		1	8		1	8		1	13		1	13		1
Perfluorooctanoic acid (PFOA)	ng/l	335-67-1	70	76	J-	1	180		1	150		1	600		10	150		1	180	J	1	140		1	150		1	230		1	200		1	34		1	49		1	110		1	38		1
Perfluorononanoic acid	ng/l	375-95-1	NE	2	J	1	10		1	12		1	12		1	9		1	7	J	1	10	J	1	13		1	13		1	5	J+	1	5		1	3	J+	1	3		1	13		1
Perfluorodecanoic acid	ng/l	335-76-2	NE		U	1	2	J+	1	1	J	1	7		1	1	J	1	2	J	1	2	J+	1	3		1	2	J	1	1	J+	1	2		1	1	J+	1	5		1	12		1
Perfluoroundecanoic acid	ng/l	2058-94-8	NE		U	2		U	2		U	2		UJ	2		U	2		UJ	2		U	2		U	2		U	2		U	2		U	2		U	2		U	2	4	J	2
Perfluorododecanoic acid	ng/l	307-55-1	NE		UJ	3		U	3		U	3		UJ	3		U	3		UJ	3		U	3		U	3		U	3		U	3		U	3		U	3		U	3		U	3
Perfluorotridecanoic acid	ng/l	72629-94-8	NE		UJ	2		U	2		U	2		UJ	2		U	2		UJ	2		U	2		U	2		U	2		U	2		U	2		U	2		U	2		U	2
Perfluorotetradecanoic acid	ng/l	376-06-7	NE		UJ	3		U	3		U	3		UJ	3		U	3		UJ	3		U	3		U	3		U	3		U	3		U	3		U	3		U	3		U	3
Perfluorobutane Sulfonate	ng/l	29420-43-3	NE		UJ	4		UJ	4	6	J	4		U	4		U	4		UJ	4		UJ	4		UJ	4		U	4		U	4		U	4		U	4		U	4		U	4
Perfluorohexane Sulfonate	ng/l	108427-53-8	NE		U	4	41		4	19		4	73		4	21		4	53	J	4	14	J+	4	7	J	4	25		4	26		4		U	4	17		4	35		4	18		4
Perfluorooctane Sulfonate (PFOS)	ng/l	1763-23-1	70	7	J	5	29		5	18		5	64		5	19		5	16	J+	5	14	J	5	23		5	19		5	22		5		U	5	12		5	24		5	15		5
N-methyl perfluorooctanesulfonamidoacetic Acid	ng/l	2355-31-9	NE		U	4		U	4		UJ	4	4	J	4		U	4		UJ	4		U	4		U	4		UJ	4		U	4		U	4		U	4		UJ	4		UJ	4
N-ethyl perfluorooctanesulfonamidoacetic Acid	ng/l	2991-50-6	NE		UJ	5		UJ	5		U	5		UJ	5		U	5		UJ	5		UJ	5		UJ	5		U	5		U	5		U	5		U	5		UJ	5		UJ	5
Total PFOA + PFOS	ng/l	NA	70	83			209			168			664			169			196			154			173			249			222			34			61			134			53		

Attachment Table 2-1 (continued)
September-October 2016 Semi-Annual Monitoring Program - Summary of Detected PFCs
Delaware Sand & Gravel Superfund Site
New Castle, Delaware

			Sample ID	DDA-16-US			DDA-17			DGC-2S			DGC-5			DGC-5			DGC-7S			MHW-1D			DGC-11D			DGC-11S			RT-1-UP			UPA-01			UPA-02D			UPA-02S			UPA-03D		
			Sample Date	9/27/2016			9/28/2016			9/27/2016			10/10/2016			10/10/2016			10/10/2016			10/6/2016			10/3/2016			10/3/2016			10/5/2016			10/6/2016			9/29/2016			9/29/2016			10/3/2016		
			N=Normal, FD=Field Duplicate	N			N			N			FD			N			N			N			N			N			N			N			N			N			FD		
Parameter	Unit	CAS	HA	Result	Qual	RDL	Result	Qual	RDL	Result	Qual	RDL	Result	Qual	RDL	Result	Qual	RDL	Result	Qual	RDL	Result	Qual	RDL	Result	Qual	RDL	Result	Qual	RDL	Result	Qual	RDL	Result	Qual	RDL	Result	Qual	RDL	Result	Qual	RDL	Result	Qual	RDL
Perfluorohexanoic acid	ng/l	307-24-4	NE	29		1	57		1	34		1	44		1	55		1	23		1	``		1	22	J	1		UJ	1	3		1	38	J-	1	27		1	44		1	45	J	1
Perfluoroheptanoic acid	ng/l	375-85-9	NE	20	J+	1	34	J+	1	23	J+	1	29		1	31	J+	1	16		1	31		1	12	J	1		UJ	1		U	1	23		1	18		1	21		1	26	J	1
Perfluorooctanoic acid (PFOA)	ng/l	335-67-1	70	200		1	290		1	200		1	160		1	190		1	130		1	280		1	43	J+	1		UJ	1	2		1	120		1	180		1	60		1	170	J	1
Perfluorononanoic acid	ng/l	375-95-1	NE	7	J	1	7	J+	1	9	J+	1	5	J+	1	6	J+	1	10		1	13	J+	1	13	J	1		UJ	1		U	1	6		1	9		1	2		1	8	J	1
Perfluorodecanoic acid	ng/l	335-76-2	NE	1	J+	1	2	J+	1		U	1		U	1		U	1	1	J	1	2		1	3	J	1		UJ	1		U	1	5		1	3		1		U	1	13	J+	1
Perfluoroundecanoic acid	ng/l	2058-94-8	NE		U	2		U	2		U	2		U	2		U	2		U	2		U	2		UJ	2		UJ	2		U	2		U	2		U	2		U	2		UJ	2
Perfluorododecanoic acid	ng/l	307-55-1	NE		U	3		U	3		U	3		U	3		U	3		U	3		U	3		UJ	3		UJ	3		U	3		U	3		U	3		UJ	3		UJ	3
Perfluorotridecanoic acid	ng/l	72629-94-8	NE		U	2		U	2		U	2		U	2		U	2		U	2		U	2		UJ	2		UJ	2		U	2		U	2		U	2		UJ	2		UJ	2
Perfluorotetradecanoic acid	ng/l	376-06-7	NE		U	3		U	3		U	3		U	3		U	3		U	3		U	3		UJ	3		UJ	3		U	3		U	3		U	3		UJ	3		UJ	3
Perfluorobutane Sulfonate	ng/l	29420-43-3	NE		UJ	4		U	4		UJ	4		U	4		U	4		U	4		U	4		UJ	4		UJ	4		U	4		U	4		U	4		U	4		UJ	4
Perfluorohexane Sulfonate	ng/l	108427-53-8	NE	17		4	56	J+	4	6	J	4	7	J	4	7	J	4	9	J	4	14		4		UJ	4		UJ	4		U	4	52		4	34		4	5	J	4	110	J+	4
Perfluorooctane Sulfonate (PFOS)	ng/l	1763-23-1	70	17	J+	5	34	J+	5	12	J+	5	9	J	5	12		5	15		5	16		5	7	J+	5		UJ	5		U	5	29		5	21		5		U	5	50	J+	5
N-methyl perfluorooctanesulfonamidoacetic Acid	ng/l	2355-31-9	NE		U	4		U	4		U	4		U	4		U	4		U	4		U	4		UJ	4		UJ	4		U	4		U	4		UJ	4		UJ	4		UJ	4
N-ethyl perfluorooctanesulfonamidoacetic Acid	ng/l	2991-50-6	NE		UJ	5		U	5		UJ	5		U	5		U	5		U	5		U	5		UJ	5		UJ	5		U	5		U	5		UJ	5		UJ	5		UJ	5
Total PFOA + PFOS	ng/l	NA	70	217			324			212			169			202			145			296			50			0			2			149			201			60			220		

Golder Associates

Attachment Table 2-1 (continued)
September-October 2016 Semi-Annual Monitoring Program - Summary of Detected PFCs
Delaware Sand & Gravel Superfund Site
New Castle, Delaware

			Sample ID	UPA-03D			AWC-E1			AWC-E1			BW-1			BW-2			MW-18			MW-26N			MW-28			MW-29			MW-29			MW-31			MW-34			P-4_UPA			P-5L		
			Sample Date	10/3/2016			10/13/2016			10/13/2016			10/4/2016			10/4/2016			10/7/2016			10/3/2016			10/5/2016			10/5/2016			10/5/2016			10/5/2016			10/7/2016			10/14/2016			10/7/2016		
			N=Normal, FD=Field Duplicate	N			FD			N			N			N			N			N			N			FD			N			N			N			N			N		
Parameter	Unit	CAS	HA	Result	Qual	RDL	Result	Qual	RDL	Result	Qual	RDL	Result	Qual	RDL	Result	Qual	RDL	Result	Qual	RDL	Result	Qual	RDL	Result	Qual	RDL	Result	Qual	RDL	Result	Qual	RDL	Result	Qual	RDL	Result	Qual	RDL	Result	Qual	RDL	Result	Qual	RDL
Perfluorohexanoic acid	ng/l	307-24-4	NE	51	J	1	29		1	29		1	25	J	1	20	J	1	28	J-	1	20	J	1	40		1	30	J	1	31	J	1	40	J-	1	18		1	86		1	9		1
Perfluoroheptanoic acid	ng/l	375-85-9	NE	29	J+	1	16		1	16		1	16	J	1	13	J	1	20		1	11	J+	1	23		1	19	J	1	19	J	1	28		1	10		1	33		1	5	J+	1
Perfluorooctanoic acid (PFOA)	ng/l	335-67-1	70	180	J	1	86		1	84		1	130	J	1	83	J	1	150	J-	1	87	J	1	54		1	130	J	1	120	J	1	190	J-	1	66		1	170		1	35		1
Perfluorononanoic acid	ng/l	375-95-1	NE	8	J+	1	10		1	10		1	10	J+	1	9	J	1	6		1	4	J+	1	3	J+	1	9	J	1	9	J	1	6		1	5		1	68		1	1	J+	1
Perfluorodecanoic acid	ng/l	335-76-2	NE	13	J+	1	2		1	3		1		UJ	1	2	J	1	2	J	1	1	J+	1		U	1	2	J	1	2	J	1		U	1		U	1	1	J	1		U	1
Perfluoroundecanoic acid	ng/l	2058-94-8	NE		UJ	2		U	2		U	2		UJ	2		UJ	2		U	2		UJ	2		U	2		UJ	2		UJ	2		U	2		U	2		U	2		U	2
Perfluorododecanoic acid	ng/l	307-55-1	NE		UJ	3		U	3		U	3		UJ	3		UJ	3		U	3		UJ	3		U	3		UJ	3		UJ	3		UJ	3		U	3		U	3		U	3
Perfluorotridecanoic acid	ng/l	72629-94-8	NE		UJ	2		U	2		U	2		UJ	2		UJ	2		U	2		UJ	2		U	2		UJ	2		UJ	2		UJ	2		U	2		U	2		U	2
Perfluorotetradecanoic acid	ng/l	376-06-7	NE		UJ	3		U	3		U	3		UJ	3		UJ	3		U	3		UJ	3		U	3		UJ	3		UJ	3		UJ	3		U	3		U	3		U	3
Perfluorobutane Sulfonate	ng/l	29420-43-3	NE		UJ	4		U	4		U	4		UJ	4		UJ	4		U	4		UJ	4	6	J	4		UJ	4		UJ	4	4	J	4		U	4	29		4		U	4
Perfluorohexane Sulfonate	ng/l	108427-53-8	NE	110	J	4	10	J	4	9	J	4	16	J	4	11	J	4	25		4	17	J	4	8	J	4	10	J	4	10	J	4	10		4	14		4	190		4	7	J	4
Perfluorooctane Sulfonate (PFOS)	ng/l	1763-23-1	70	55	J+	5	11		5	10	J	5	18	J+	5	17	J	5	47		5	11	J+	5	9	J	5	120	J	5	130	J	5	100		5	14		5	28		5	5	J	5
N-methyl perfluorooctanesulfonamidoacetic Acid	ng/l	2355-31-9	NE		UJ	4		U	4		U	4		UJ	4		UJ	4		U	4		UJ	4		U	4		UJ	4		UJ	4		U	4		U	4		U	4		U	4
N-ethyl perfluorooctanesulfonamidoacetic Acid	ng/l	2991-50-6	NE		UJ	5		U	5		U	5		UJ	5		UJ	5		U	5		UJ	5		U	5		UJ	5		UJ	5	25		5		U	5		U	5		U	5
Total PFOA + PFOS	ng/l	NA	70	235			97			94			148			100			197			98			63			250			250			290			80			198			40		

Attachment Table 2-1 (continued)
September-October 2016 Semi-Annual Monitoring Program - Summary of Detected PFCs
Delaware Sand & Gravel Superfund Site
New Castle, Delaware

			Sample ID	P-5U			P-6_UPA			UPA-101-TZ			UPA-101-US			AWC-E1			AWC-E2			AWC-E2			AWC-K1		
			Sample Date	10/7/2016			9/28/2016			9/28/2016			9/28/2016			10/13/2016			10/13/2016			10/13/2016			10/13/2016		
			N=Normal, FD=Field Duplicate	N			N			N			N			N			N			N			N		
Parameter	Unit	CAS	HA	Result	Qual	RDL	Result	Qual	RDL	Result	Qual	RDL	Result	Qual	RDL	Result	Qual	RDL	Result	Qual	RDL	Result	Qual	RDL	Result	Qual	RDL
Perfluorohexanoic acid	ng/l	307-24-4	NE	46		1	38	J-	1	47	J-	1	52		1	30		1	30		1	33		1	7		1
Perfluoroheptanoic acid	ng/l	375-85-9	NE	23		1	33		1	22	J+	1	29	J+	1	15	J+	1	12		1	15		1	4	J+	1
Perfluorooctanoic acid (PFOA)	ng/l	335-67-1	70	76		1	140	J-	1	130		1	210		1	76		1	110		1	130		1	23		1
Perfluorononanoic acid	ng/l	375-95-1	NE	8		1	10		1	4		1	8		1	12	J+	1	6		1	5		1	2	J+	1
Perfluorodecanoic acid	ng/l	335-76-2	NE	4		1	4		1		U	1	5		1	4		1	3		1	3		1		U	1
Perfluoroundecanoic acid	ng/l	2058-94-8	NE	5		2		U	2		U	2		U	2		U	2		U	2		U	2		U	2
Perfluorododecanoic acid	ng/l	307-55-1	NE		U	3		U	3		U	3		U	3		U	3		U	3		UJ	3		U	3
Perfluorotridecanoic acid	ng/l	72629-94-8	NE		U	2		U	2		U	2		U	2		U	2		U	2		UJ	2		U	2
Perfluorotetradecanoic acid	ng/l	376-06-7	NE		U	3		U	3		U	3		U	3		U	3		U	3		UJ	3		U	3
Perfluorobutane Sulfonate	ng/l	29420-43-3	NE		U	4		U	4		U	4		U	4		U	4		U	4		U	4		U	4
Perfluorohexane Sulfonate	ng/l	108427-53-8	NE		U	4	44		4	8	J	4	50	J+	4	8	J	4	30		4	26		4	6	J	4
Perfluorooctane Sulfonate (PFOS)	ng/l	1763-23-1	70		U	5	21		5		U	5	37		5	11		5	14		5	15		5	6	J	5
N-methyl perfluorooctanesulfonamidoacetic Acid	ng/l	2355-31-9	NE		U	4		U	4		UJ	4		U	4		U	4		U	4		U	4		U	4
N-ethyl perfluorooctanesulfonamidoacetic Acid	ng/l	2991-50-6	NE		U	5		U	5		UJ	5		U	5		U	5		U	5		U	5		U	5
Total PFOA + PFOS	ng/l	NA	70	76			161			130			247			87			124			145			29		

Golder Associates

Attachment Table 2-1 (continued)
September-October 2016 Semi-Annual Monitoring Program - Summary of Detected PFCs
Delaware Sand & Gravel Superfund Site
New Castle, Delaware

Notes:
Green highlight = Concentration exceeds HA

Abbreviations:
HA = the May 19, 2016 USEPA health advisory (HA) of 70 nanograms per liter (ng/l; parts per trillion [ppt]) for perfluorooctanoic acid (PFOA), perfluorooctane sulfonate (PFOS), and/or the combined concentrations of PFOA and PFOS
ng/L = nanograms per liter
Qual = interpreted qualifier
RDL = reporting detection limit
NE = standard does not exist
PFCs = perfluorinated compounds
Qualifiers:
J - The analyte is present; however, the reported value may not be accurate or precise.
J+ - The analyte is present; however, the reported value may not be accurate or precise. The result is biased high.
J- - The analyte is present; however, the reported value may not be accurate or precise. The result is biased low.
U - not detected above RDL
UJ - not detected above RDL, RDL is estimated

Prepared by: AZ
Checked by: BPC
Reviewed by: RWB

Attachment Table 2-2
March-April 2017 Semi-Annual Monitoring Program - Summary of Detected PFCs
Delaware Sand & Gravel Superfund Site
New Castle, Delaware

				DDA Monitoring Wells			PW-1(U) Monitoring Wells - UPCU Transition Zone			PW-1(U) Monitoring Wells - UPA Upper Sand																				
			Sample ID	DGC-8C			DDA-05			DDA-01			DDA-02			DDA-03			DDA-07-US			DDA-10-US			DDA-11-LS			DDA-11-US		
			Sample Date	4/3/2017			4/12/2017			4/12/2017			4/12/2017			4/5/2017			4/13/2017			4/11/2017			4/4/2017			4/4/2017		
			Sample Depth (ft)	-			-			-			-			-			-			-			-			-		
			N=Normal, FD=Field Duplicate	N			N			N			N			N			N			N			N			N		
Parameter	Unit	CAS	HA	Result	Qual	RDL	Result	Qual	RDL	Result	Qual	RDL	Result	Qual	RDL	Result	Qual	RDL	Result	Qual	RDL	Result	Qual	RDL	Result	Qual	RDL	Result	Qual	RDL
Perfluorohexanoic acid	ng/l	307-24-4	NE	39	J-	0.6	22		0.6	27		0.6	24		0.6	53		0.6	22		0.6	49	J-	0.6	26	J-	0.6	36	J-	0.6
Perfluoroheptanoic acid	ng/l	375-85-9	NE	14		0.5	14		0.5	20		0.5	16		0.5	47		0.5	14		0.5	32		0.5	20		0.5	26	J-	0.5
Perfluoro-n-octanoic acid (PFOA)	ng/l	335-67-1	70	30		0.6	100		0.6	160		0.6	140		0.6	530		0.6	140		0.6	170		0.6	140		0.6	140		0.6
Perfluorononanoic acid	ng/l	375-95-1	NE	3		0.6	5		0.6	8		0.6	8		0.6	10		0.6	9		0.6	7		0.6	11		0.6	12		0.6
Perfluorodecanoic acid	ng/l	335-76-2	NE	1	J	0.5	0.6	J	0.5	2		0.5	2	J-	0.5	5		0.5	2	J	0.5	2	J	0.5	1	J	0.5	3	J-	0.5
Perfluoroundecanoic acid	ng/l	2058-94-8	NE		U	1		U	1		U	1		U	1		U	1		U	1		U	1		UJ	1		UJ	1
Perfluorododecanoic acid	ng/l	307-55-1	NE		UJ	0.5		U	0.5		U	0.5		UJ	0.5		UJ	0.5		U	0.5		UJ	0.5		UJ	0.5		UJ	0.5
Perfluorotridecanoic acid	ng/l	72629-94-8	NE		UJ	0.5		U	0.5		U	0.5		UJ	0.5		UJ	0.5		U	0.5		UJ	0.5		UJ	0.5		UJ	0.5
Perfluorotetradecanoic acid	ng/l	376-06-7	NE		UJ	0.5		U	0.5		UJ	0.5		UJ	0.5		UJ	0.5	0.6	J	0.5		UJ	0.5		UJ	0.5		UJ	0.5
Perfluorobutanesulfonic acid (PFBS)	ng/l	375-73-5	NE	1	J+	0.8	1	J	0.8	1	J	0.8	1	J	0.8	1	J	0.8	2	J	0.8	2	J	0.8		U	0.8	2	J	0.8
Perfluorohexanesulfonic acid (PFHxS)	ng/l	355-46-4	NE	1	J	1	7	J-	1	33		1	23		1	68		1	18		1	35	J-	1	12		1	5	J-	1
Perfluoro-1-Octanesulfonate (PFOS)	ng/l	1763-23-1	70	4	J	2	10		2	33		2	28		2	77	J-	2	21		2	20		2	15		2	21		2
N-methyl perfluorooctanesulfonamidoacetic Acid	ng/l	2355-31-9	NE		UJ	1		U	1		U	1		U	1		UJ	1		U	1		UJ	1		UJ	1		U	1
N-ethyl perfluorooctanesulfonamidoacetic Acid	ng/l	2991-50-6	NE		U	1		U	1		U	1		U	1		U	1		U	1		U	1		UJ	1		U	1
Total PFOA + PFOS	ng/l	NA	70	34			110			193			168			607			161			190			155			161		

Attachment Table 2-2 (continued)
March-April 2017 Semi-Annual Monitoring Program - Summary of Detected PFCs
Delaware Sand & Gravel Superfund Site
New Castle, Delaware

				PW-1(U) Monitoring Wells - UPA Upper Sand																							
			Sample ID	DDA-12-US			DDA-15-US			DDA-16-US			DDA-17			DGC-2S			DGC-5			DGC-7S			MHW-1D		
			Sample Date	4/12/2017			4/13/2017			4/12/2017			4/5/2017			4/12/2017			4/11/2017			4/10/2017			4/12/2017		
			Sample Depth (ft)	-			-			-			-			-			-			-			-		
			N=Normal, FD=Field Duplicate	N			N			N			N			N			N			N			N		
Parameter	Unit	CAS	HA	Result	Qual	RDL	Result	Qual	RDL	Result	Qual	RDL	Result	Qual	RDL	Result	Qual	RDL	Result	Qual	RDL	Result	Qual	RDL	Result	Qual	RDL
Perfluorohexanoic acid	ng/l	307-24-4	NE	37		0.6	22		0.6	26		0.6	50		0.6	32		0.6	50		0.6	24	J-	0.6	39		0.6
Perfluoroheptanoic acid	ng/l	375-85-9	NE	25		0.5	18		0.5	19		0.5	35		0.5	23		0.5	42		0.5	19	J-	0.5	30		0.5
Perfluoro-n-octanoic acid (PFOA)	ng/l	335-67-1	70	150		0.6	220		0.6	190		0.6	340		0.6	200		0.6	270		0.6	160	J-	0.6	240		0.6
Perfluorononanoic acid	ng/l	375-95-1	NE	6		0.6	5		0.6	6		0.6	10		0.6	10		0.6	9		0.6	11		0.6	16		0.6
Perfluorodecanoic acid	ng/l	335-76-2	NE		U	0.5	2	J	0.5	1	J-	0.5	3	J-	0.5	1	J	0.5	1	J	0.5	2	J-	0.5	3		0.5
Perfluoroundecanoic acid	ng/l	2058-94-8	NE		U	1		U	1		U	1		UJ	1		U	1		U	1		UJ	1		U	1
Perfluorododecanoic acid	ng/l	307-55-1	NE		U	0.5		U	0.5		UJ	0.5		UJ	0.5		U	0.5		U	0.5		UJ	0.5		U	0.5
Perfluorotridecanoic acid	ng/l	72629-94-8	NE		U	0.5		U	0.5		UJ	0.5		UJ	0.5		U	0.5		U	0.5		UJ	0.5		U	0.5
Perfluorotetradecanoic acid	ng/l	376-06-7	NE		U	0.5	0.6	J	0.5		UJ	0.5		UJ	0.5		U	0.5		U	0.5		UJ	0.5		UJ	0.5
Perfluorobutanesulfonic acid (PFBS)	ng/l	375-73-5	NE		U	0.8	1	J	0.8	1	J	0.8	1	J	0.8	1	J	0.8	3	J	0.8	1	J	0.8	2	J	0.8
Perfluorohexanesulfonic acid (PFHxS)	ng/l	355-46-4	NE	4		1	25	J-	1	14		1	57	J-	1	4		1	16		1	10	J-	1	14		1
Perfluoro-1-Octanesulfonate (PFOS)	ng/l	1763-23-1	70	3	J	2	24		2	17		2	47		2	10		2	10		2	22		2	31		2
N-methyl perfluorooctanesulfonamidoacetic Acid	ng/l	2355-31-9	NE		U	1		U	1		U	1		U	1		U	1		U	1		U	1		UJ	1
N-ethyl perfluorooctanesulfonamidoacetic Acid	ng/l	2991-50-6	NE		U	1		U	1		U	1		U	1		U	1		U	1		U	1		U	1
Total PFOA + PFOS	ng/l	NA	70	153			244			207			387			210			280			182			271		

Attachment Table 2-2 (continued)
March-April 2017 Semi-Annual Monitoring Program - Summary of Detected PFCs
Delaware Sand & Gravel Superfund Site
New Castle, Delaware

				PW-1(U) Monitoring Wells - UPA Upper Sand						Downgradient UPA Wells																			
			Sample ID	PW-1(U)			PW-1(U)			AWC-E1			AWC-E1			AWC-E2			AWC-E2			DGC-10D			DGC-10S			DGC-11D		
			Sample Date	3/28/2017			4/11/2017			4/17/2017			4/17/2017			4/17/2017			4/17/2017			4/7/2017			4/7/2017			4/5/2017		
			Sample Depth (ft)	-			-			132			156			140			165			-			-			-		
			N=Normal, FD=Field Duplicate	N			N			N			N			N			N			N			N			N		
Parameter	Unit	CAS	HA	Result	Qual	RDL	Result	Qual	RDL	Result	Qual	RDL	Result	Qual	RDL	Result	Qual	RDL	Result	Qual	RDL	Result	Qual	RDL	Result	Qual	RDL	Result	Qual	RDL
Perfluorohexanoic acid	ng/l	307-24-4	NE	29		0.6	25		0.6	22		0.6	26		0.6	23		0.6	21		0.6	20		0.6	30	J-	0.6	27		0.6
Perfluoroheptanoic acid	ng/l	375-85-9	NE	18		0.5	17		0.5	14		0.5	19		0.5	14		0.5	15		0.5	13		0.5	17		0.5	18		0.5
Perfluoro-n-octanoic acid (PFOA)	ng/l	335-67-1	70	170		0.6	140		0.6	80		0.6	100		0.6	93		0.6	100		0.6	120		0.6	44		0.6	52		0.6
Perfluorononanoic acid	ng/l	375-95-1	NE	9		0.6	7		0.6	7		0.6	10		0.6	5		0.6	6		0.6	4		0.6	10		0.6	18		0.6
Perfluorodecanoic acid	ng/l	335-76-2	NE	2	J	0.5	2	J-	0.5	2	J	0.5	3		0.5	2	J	0.5	2		0.5	5		0.5	5		0.5	4		0.5
Perfluoroundecanoic acid	ng/l	2058-94-8	NE		U	1		U	1		U	1	1	J	1		U	1		U	1	1	J	1	2	J	1	1	J	1
Perfluorododecanoic acid	ng/l	307-55-1	NE		U	0.5		UJ	0.5		U	0.5		U	0.5		U	0.5		U	0.5		U	0.5	1	J-	0.5		U	0.5
Perfluorotridecanoic acid	ng/l	72629-94-8	NE		U	0.5		UJ	0.5		U	0.5		U	0.5		U	0.5		U	0.5		U	0.5		UJ	0.5		U	0.5
Perfluorotetradecanoic acid	ng/l	376-06-7	NE		UJ	0.5		UJ	0.5		U	0.5		U	0.5		U	0.5		U	0.5		U	0.5		UJ	0.5		UJ	0.5
Perfluorobutanesulfonic acid (PFBS)	ng/l	375-73-5	NE	1	J	0.8	1	J	0.8	2	J	0.8	2	J	0.8	1	J+	0.8	1	J	0.8	0.9	J	0.8	2	J+	0.8	3	J	0.8
Perfluorohexanesulfonic acid (PFHxS)	ng/l	355-46-4	NE	22		1	18	J-	1	7		1	8	J-	1	16		1	18		1	36		1	12		1	4	J-	1
Perfluoro-1-Octanesulfonate (PFOS)	ng/l	1763-23-1	70	21		2	21		2	14		2	15		2	11		2	16		2	27		2	16		2	9		2
N-methyl perfluorooctanesulfonamidoacetic Acid	ng/l	2355-31-9	NE		U	1		U	1		U	1		U	1		U	1		U	1		UJ	1		UJ	1		UJ	1
N-ethyl perfluorooctanesulfonamidoacetic Acid	ng/l	2991-50-6	NE		U	1		U	1		U	1		U	1		U	1		U	1		U	1		UJ	1		U	1
Total PFOA + PFOS	ng/l	NA	70	191			161			94			115			104			116			147			60			61		

Attachment Table 2-2 (continued)
March-April 2017 Semi-Annual Monitoring Program - Summary of Detected PFCs
Delaware Sand & Gravel Superfund Site
New Castle, Delaware

				NCC UPA Monitoring Wells and P-6 Vicinity																							
			Sample ID	BW-1			BW-2			MW-18			MW-26N			MW-28			MW-29			MW-29			MW-31		
			Sample Date	4/3/2017			4/3/2017			3/30/2017			4/5/2017			3/29/2017			3/29/2017			3/29/2017			3/29/2017		
			Sample Depth (ft)	-			-			-			-			-			-			-			-		
			N=Normal, FD=Field Duplicate	N			N			N			N			N			FD			N			N		
Parameter	Unit	CAS	HA	Result	Qual	RDL	Result	Qual	RDL	Result	Qual	RDL	Result	Qual	RDL	Result	Qual	RDL	Result	Qual	RDL	Result	Qual	RDL	Result	Qual	RDL
Perfluorohexanoic acid	ng/l	307-24-4	NE	39		0.6	27	J-	0.6	26		0.6	28		0.6	40		0.6	31		0.6	36		0.6	39		0.6
Perfluoroheptanoic acid	ng/l	375-85-9	NE	26		0.5	21		0.5	19		0.5	15		0.5	20		0.5	25		0.5	25		0.5	26		0.5
Perfluoro-n-octanoic acid (PFOA)	ng/l	335-67-1	70	150		0.6	120		0.6	150		0.6	130		0.6	50		0.6	180		0.6	190		0.6	180		0.6
Perfluorononanoic acid	ng/l	375-95-1	NE	15		0.6	11		0.6	8		0.6	5		0.6	4		0.6	13		0.6	14		0.6	6		0.6
Perfluorodecanoic acid	ng/l	335-76-2	NE	0.6	J	0.5	2		0.5	2	J	0.5	2		0.5	1	J	0.5	3		0.5	3		0.5	1	J-	0.5
Perfluoroundecanoic acid	ng/l	2058-94-8	NE		U	1	1	J	1		U	1		UJ	1		U	1		U	1		U	1		UJ	1
Perfluorododecanoic acid	ng/l	307-55-1	NE		UJ	0.5		UJ	0.5		U	0.5		UJ	0.5		U	0.5		U	0.5		UJ	0.5		UJ	0.5
Perfluorotridecanoic acid	ng/l	72629-94-8	NE		UJ	0.5		UJ	0.5		U	0.5		UJ	0.5		U	0.5		U	0.5		U	0.5		U	0.5
Perfluorotetradecanoic acid	ng/l	376-06-7	NE		UJ	0.5		UJ	0.5		U	0.5		UJ	0.5		U	0.5		U	0.5		UJ	0.5		UJ	0.5
Perfluorobutanesulfonic acid (PFBS)	ng/l	375-73-5	NE	6		0.8	2	J	0.8	3	J	0.8	2	J	0.8	4		0.8	3	J	0.8	3	J	0.8	3	J	0.8
Perfluorohexanesulfonic acid (PFHxS)	ng/l	355-46-4	NE	17		1	12		1	18		1	23		1	9		1	11		1	10		1	9		1
Perfluoro-1-Octanesulfonate (PFOS)	ng/l	1763-23-1	70	41		2	33		2	41		2	15		2	12		2	120		2	130		2	99		2
N-methyl perfluorooctanesulfonamidoacetic Acid	ng/l	2355-31-9	NE		UJ	1		UJ	1		UJ	1		UJ	1		U	1		U	1		UJ	1		U	1
N-ethyl perfluorooctanesulfonamidoacetic Acid	ng/l	2991-50-6	NE		UJ	1		UJ	1		U	1		UJ	1		U	1	1	J	1	1	J	1	14		1
Total PFOA + PFOS	ng/l	NA	70	191			153			191			145			62			300			320			279		

Attachment Table 2-2 (continued)
March-April 2017 Semi-Annual Monitoring Program - Summary of Detected PFCs
Delaware Sand & Gravel Superfund Site
New Castle, Delaware

				NCC UPA Monitoring Wells and P-6 Vicinity																							
			Sample ID	BW-1			BW-2			MW-18			MW-26N			MW-28			MW-29			MW-29			MW-31		
			Sample Date	4/3/2017			4/3/2017			3/30/2017			4/5/2017			3/29/2017			3/29/2017			3/29/2017			3/29/2017		
			Sample Depth (ft)	-			-			-			-			-			-			-			-		
			N=Normal, FD=Field Duplicate	N			N			N			N			N			FD			N			N		
Parameter	Unit	CAS	HA	Result	Qual	RDL	Result	Qual	RDL	Result	Qual	RDL	Result	Qual	RDL	Result	Qual	RDL	Result	Qual	RDL	Result	Qual	RDL	Result	Qual	RDL
Perfluorohexanoic acid	ng/l	307-24-4	NE	39		0.6	27	J-	0.6	26		0.6	28		0.6	40		0.6	31		0.6	36		0.6	39		0.6
Perfluoroheptanoic acid	ng/l	375-85-9	NE	26		0.5	21		0.5	19		0.5	15		0.5	20		0.5	25		0.5	25		0.5	26		0.5
Perfluoro-n-octanoic acid (PFOA)	ng/l	335-67-1	70	150		0.6	120		0.6	150		0.6	130		0.6	50		0.6	180		0.6	190		0.6	180		0.6
Perfluorononanoic acid	ng/l	375-95-1	NE	15		0.6	11		0.6	8		0.6	5		0.6	4		0.6	13		0.6	14		0.6	6		0.6
Perfluorodecanoic acid	ng/l	335-76-2	NE	0.6	J	0.5	2		0.5	2	J	0.5	2		0.5	1	J	0.5	3		0.5	3		0.5	1	J-	0.5
Perfluoroundecanoic acid	ng/l	2058-94-8	NE		U	1	1	J	1		U	1		UJ	1		U	1		U	1		U	1		UJ	1
Perfluorododecanoic acid	ng/l	307-55-1	NE		UJ	0.5		UJ	0.5		U	0.5		UJ	0.5		U	0.5		U	0.5		UJ	0.5		UJ	0.5
Perfluorotridecanoic acid	ng/l	72629-94-8	NE		UJ	0.5		UJ	0.5		U	0.5		UJ	0.5		U	0.5		U	0.5		U	0.5		U	0.5
Perfluorotetradecanoic acid	ng/l	376-06-7	NE		UJ	0.5		UJ	0.5		U	0.5		UJ	0.5		U	0.5		U	0.5		UJ	0.5		UJ	0.5
Perfluorobutanesulfonic acid (PFBS)	ng/l	375-73-5	NE	6		0.8	2	J	0.8	3	J	0.8	2	J	0.8	4		0.8	3	J	0.8	3	J	0.8	3	J	0.8
Perfluorohexanesulfonic acid (PFHxS)	ng/l	355-46-4	NE	17		1	12		1	18		1	23		1	9		1	11		1	10		1	9		1
Perfluoro-1-Octanesulfonate (PFOS)	ng/l	1763-23-1	70	41		2	33		2	41		2	15		2	12		2	120		2	130		2	99		2
N-methyl perfluorooctanesulfonamidoacetic Acid	ng/l	2355-31-9	NE		UJ	1		UJ	1		UJ	1		UJ	1		U	1		U	1		UJ	1		U	1
N-ethyl perfluorooctanesulfonamidoacetic Acid	ng/l	2991-50-6	NE		UJ	1		UJ	1		U	1		UJ	1		U	1	1	J	1	1	J	1	14		1
Total PFOA + PFOS	ng/l	NA	70	191			153			191			145			62			300			320			279		

Attachment Table 2-2 (continued)
March-April 2017 Semi-Annual Monitoring Program - Summary of Detected PFCs
Delaware Sand & Gravel Superfund Site
New Castle, Delaware

				NCC UPA Monitoring Wells and P-6 Vicinity																									
			Sample ID	MW-34			MW-40			P-4_UPA			P-5L			P-5U			P-6_UPA			P-6_UPA			RW-10			RW-10		
			Sample Date	3/30/2017			4/11/2017			4/11/2017			3/30/2017			3/30/2017			4/3/2017			4/3/2017			4/11/2017			4/11/2017		
			Sample Depth (ft)	-			-			-			-			-			-			-			-			-		
			N=Normal, FD=Field Duplicate	N			N			N			N			N			FD			N			FD			N		
Parameter	Unit	CAS	HA	Result	Qual	RDL	Result	Qual	RDL	Result	Qual	RDL	Result	Qual	RDL	Result	Qual	RDL	Result	Qual	RDL	Result	Qual	RDL	Result	Qual	RDL	Result	Qual	RDL
Perfluorohexanoic acid	ng/l	307-24-4	NE	17		0.6	14		0.6	16	J-	0.6	11		0.6	33		0.6	34	J-	0.6	34	J-	0.6	45		0.6	46		0.6
Perfluoroheptanoic acid	ng/l	375-85-9	NE	10		0.5	10		0.5	11		0.5	6		0.5	18		0.5	24	J-	0.5	19		0.5	20		0.5	19		0.5
Perfluoro-n-octanoic acid (PFOA)	ng/l	335-67-1	70	71		0.6	45		0.6	20	J-	0.6	45		0.6	76		0.6	110		0.6	100		0.6	92		0.6	93		0.6
Perfluorononanoic acid	ng/l	375-95-1	NE	5		0.6	4		0.6	14		0.6	2	J	0.6	8		0.6	8		0.6	8		0.6	29		0.6	32		0.6
Perfluorodecanoic acid	ng/l	335-76-2	NE	1	J	0.5	0.7	J	0.5	7	J-	0.5	0.6	J	0.5	1	J	0.5	7		0.5	6		0.5	2		0.5	3		0.5
Perfluoroundecanoic acid	ng/l	2058-94-8	NE		U	1		U	1	3	J-	1		U	1	2	J	1	3	J-	1	3	J-	1		U	1		U	1
Perfluorododecanoic acid	ng/l	307-55-1	NE		U	0.5		U	0.5		UJ	0.5		U	0.5		U	0.5	1	J-	0.5	1	J-	0.5		UJ	0.5		U	0.5
Perfluorotridecanoic acid	ng/l	72629-94-8	NE		U	0.5		U	0.5		UJ	0.5		U	0.5		U	0.5		UJ	0.5		UJ	0.5		UJ	0.5		U	0.5
Perfluorotetradecanoic acid	ng/l	376-06-7	NE		U	0.5	0.5	J	0.5		UJ	0.5		U	0.5		U	0.5		UJ	0.5		UJ	0.5	0.7	J-	0.5		UJ	0.5
Perfluorobutanesulfonic acid (PFBS)	ng/l	375-73-5	NE	2	J	0.8	0.8	J	0.8	1	J	0.8		U	0.8	4		0.8	2	J+	0.8		UJ	0.8	9		0.8	8		0.8
Perfluorohexanesulfonic acid (PFHxS)	ng/l	355-46-4	NE	13	J-	1	11		1	6		1	8		1	4		1	52	J-	1	35		1	93	J-	1	85		1
Perfluoro-1-Octanesulfonate (PFOS)	ng/l	1763-23-1	70	19		2	17		2	5	J	2	8		2	3	J	2	21		2	19		2	11		2	11		2
N-methyl perfluorooctanesulfonamidoacetic Acid	ng/l	2355-31-9	NE		U	1		U	1		UJ	1		U	1		U	1		UJ	1		UJ	1		UJ	1		U	1
N-ethyl perfluorooctanesulfonamidoacetic Acid	ng/l	2991-50-6	NE		U	1		U	1		U	1		U	1		U	1		UJ	1		U	1		U	1		U	1
Total PFOA + PFOS	ng/l	NA	70	90			62			25			53			79			131			119			103			104		

Attachment Table 2-2 (continued)
March-April 2017 Semi-Annual Monitoring Program - Summary of Detected PFCs
Delaware Sand & Gravel Superfund Site
New Castle, Delaware

				NCC UPA Monitoring Wells and P-6 Vicinity					
			Sample ID	UPA-101-TZ			UPA-101-US		
			Sample Date	3/29/2017			4/4/2017		
			Sample Depth (ft)	-			-		
			N=Normal, FD=Field Duplicate	N			N		
Parameter	Unit	CAS	HA	Result	Qual	RDL	Result	Qual	RDL
Perfluorohexanoic acid	ng/l	307-24-4	NE	39	J-	0.6	57	J-	0.6
Perfluoroheptanoic acid	ng/l	375-85-9	NE	20		0.5	45	J-	0.5
Perfluoro-n-octanoic acid (PFOA)	ng/l	335-67-1	70	150		0.6	240		0.6
Perfluorononanoic acid	ng/l	375-95-1	NE		U	0.6	7		0.6
Perfluorodecanoic acid	ng/l	335-76-2	NE		U	0.5	5	J-	0.5
Perfluoroundecanoic acid	ng/l	2058-94-8	NE		U	1		UJ	1
Perfluorododecanoic acid	ng/l	307-55-1	NE		U	0.5		UJ	0.5
Perfluorotridecanoic acid	ng/l	72629-94-8	NE		U	0.5		UJ	0.5
Perfluorotetradecanoic acid	ng/l	376-06-7	NE		UJ	0.5		UJ	0.5
Perfluorobutanesulfonic acid (PFBS)	ng/l	375-73-5	NE	2	J+	0.8		UJ	0.8
Perfluorohexanesulfonic acid (PFHxS)	ng/l	355-46-4	NE	6		1	94	J-	1
Perfluoro-1-Octanesulfonate (PFOS)	ng/l	1763-23-1	70	5	J	2	44		2
N-methyl perfluorooctanesulfonamidoacetic Acid	ng/l	2355-31-9	NE		U	1		UJ	1
N-ethyl perfluorooctanesulfonamidoacetic Acid	ng/l	2991-50-6	NE		U	1		UJ	1
Total PFOA + PFOS	ng/l	NA	70	155			284		

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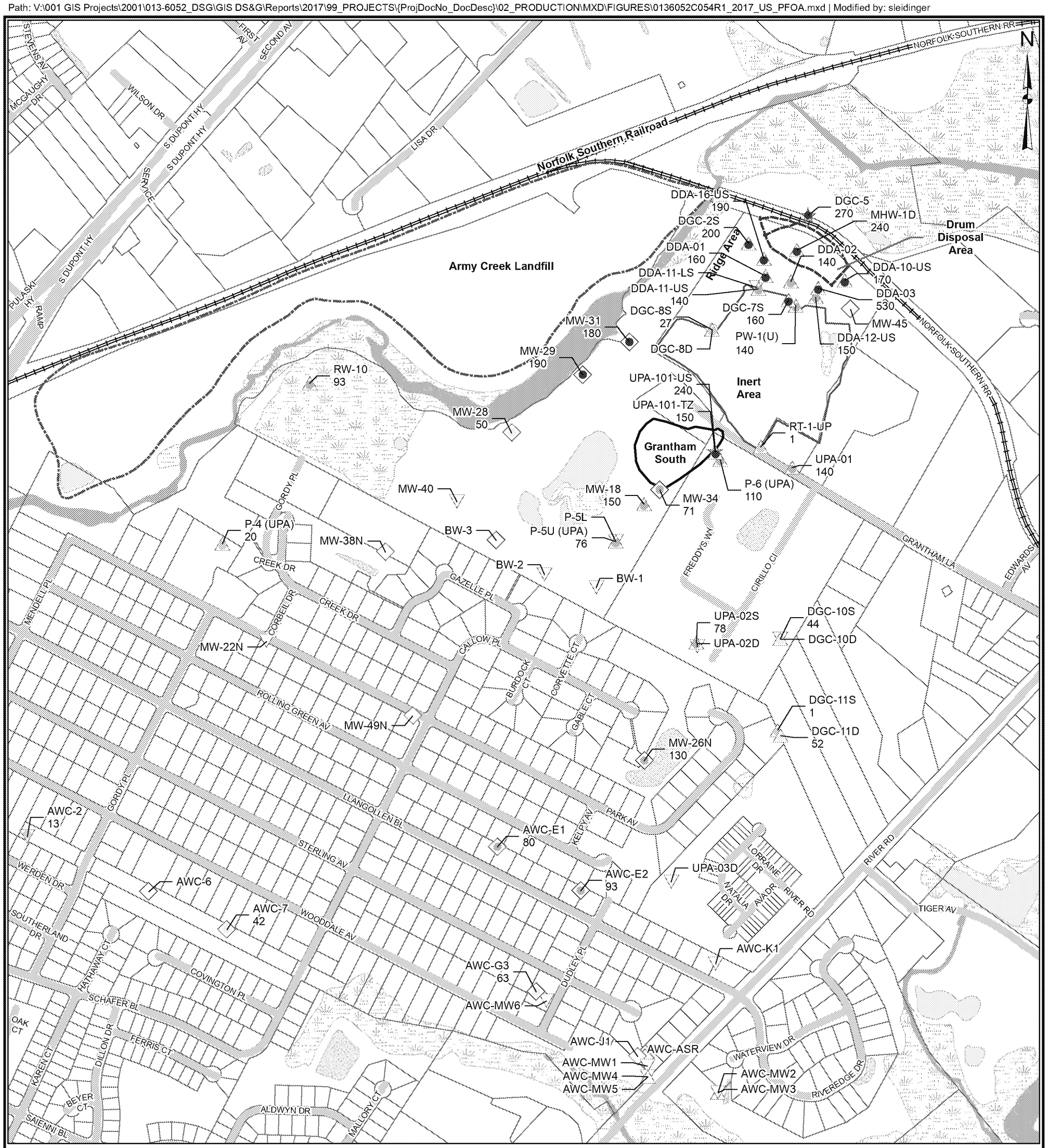

LEGEND

- Well screened in UPCU Transition Zone
- Well screened in UPA Upper Sand
- Well screened in UPA Lower Sand
- Well screened across UPA Upper Sand and Lower Sand
- Well screened in Columbia Aquifer

PFOA Detections

- <40
- 40-70
- 70-150
- >150
- 23 PFOA Concentrations (ng/L)

REFERENCE

Base data from New Castle County Delaware, Department of Land Use, "eParcel View Map" web site GIS data download. Data acquired 01/18/2012.

PFOA = Perfluorooctanoic Acid
ng/L = Nanograms per Liter
* Indicates data not used for contouring

0 300 600 1,200 Feet

FIGURE 2-1

REVIEW	TAM	9/1/2017
CHECK	BPC	9/1/2017
GIS	SHL	9/1/2017
DESIGN	RWB	9/1/2017
REV. 0	SCALE: AS SHOWN	
FILE No.	0136052C054R1_2017_US_PFOA	
PROJECT No.	013-6052.007	

TITLE

PFOA
UPA UPPER SAND
APRIL 2017

PROJECT

Delaware Sand and Gravel Superfund Site
New Castle, Delaware

Golder Associates
Manchester, New Hampshire

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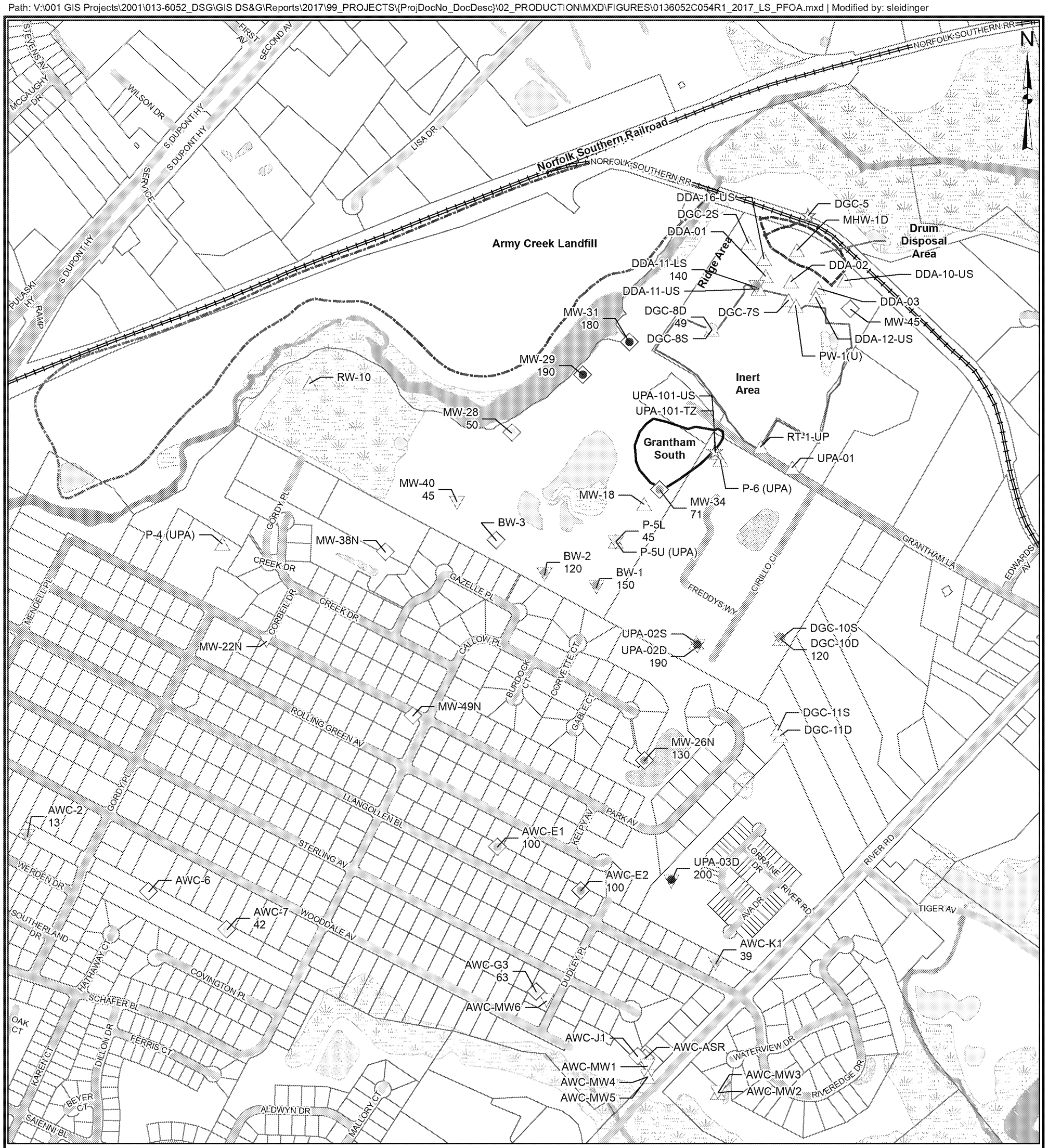

LEGEND

- ☆ Well screened in UPCU Transition Zone
- △ Well screened in UPA Upper Sand
- ▽ Well screened in UPA Lower Sand
- ◇ Well screened across UPA Upper Sand and Lower Sand
- ○ Well screened in Columbia Aquifer

PFOA Detections

- <40
- 40-70
- 70-150
- >150
- 23 PFOA Concentrations (ng/L)

REFERENCE

Base data from New Castle County Delaware, Department of Land Use, "eParcel View Map" web site GIS data download. Data acquired 01/18/2012.

PFOA = Perfluorooctanoic Acid
ng/L = Nanograms per Liter
* Indicates data not used for contouring

0 300 600 1,200 Feet

REVIEW	TAM	9/1/2017
CHECK	BPC	9/1/2017
GIS	SHL	9/1/2017
DESIGN	RWB	9/1/2017
REV. 0	SCALE: AS SHOWN	
FILE No.	0136052C054R1_2017_LS_PFOA	
PROJECT No.	013-6052.007	

FIGURE 2-2

TITLE

PFOA
UPA LOWER SAND
APRIL 2017

PROJECT

Delaware Sand and Gravel Superfund Site
New Castle, Delaware

Golder Associates
Manchester, New Hampshire

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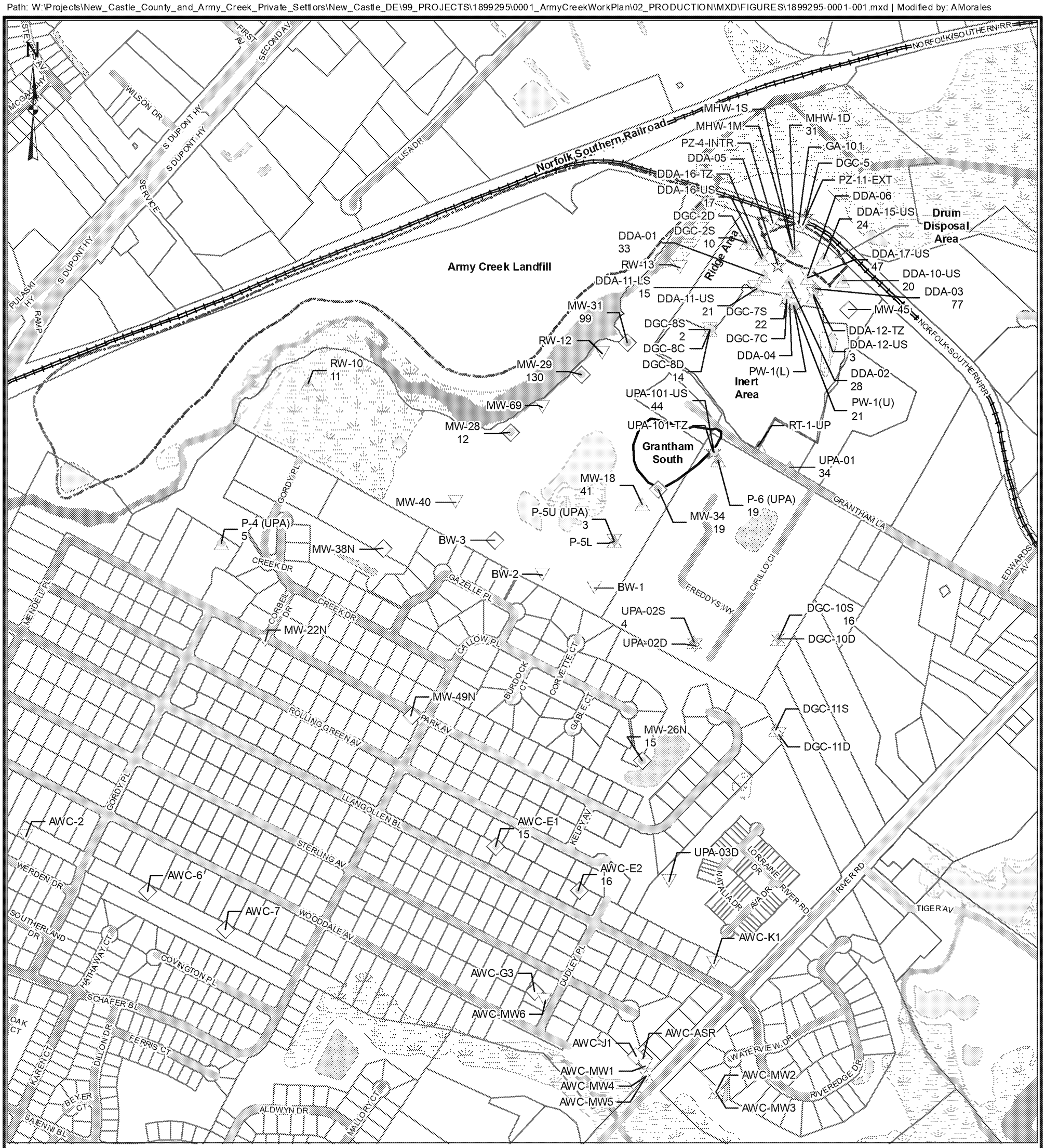

LEGEND

PFOS DETECTIONS

- < 40
- 40 - 70
- 70 - 130
- WELL SCREENED IN UPCU TRANSITION ZONE
- WELL SCREENED IN UPA UPPER SAND
- WELL SCREENED IN UPA LOWER SAND
- WELL SCREENED ACROSS UPA UPPER SAND AND LOWER SAND
- WELL SCREENED IN COLUMBIA AQUIFER
- 23 PFOS CONCENTRATIONS (ng/L)

REFERENCE

Base data from New Castle County Delaware, Department of Land Use, "eParcel View Map" web site GIS data download. Data acquired 01/18/2012.

PFOA = Perfluorooctanoic Acid
ng/L = Nanograms per Liter
* Indicates data not used for contouring

0 300 600 1,200 Feet

FIGURE 2-3

REVIEW		
CHECK		
GIS	AM	10/30/2018
DESIGN	BAR	10/30/2018
REV. 0	SCALE: AS SHOWN	
FILE No.	1899295-0001-001	
PROJECT No.	013-6052.007	

TITLE

PFOS
UPA UPPER SAND
APRIL 2017

PROJECT

Army Creek Landfill Superfund Site
New Castle, Delaware

GOLDER

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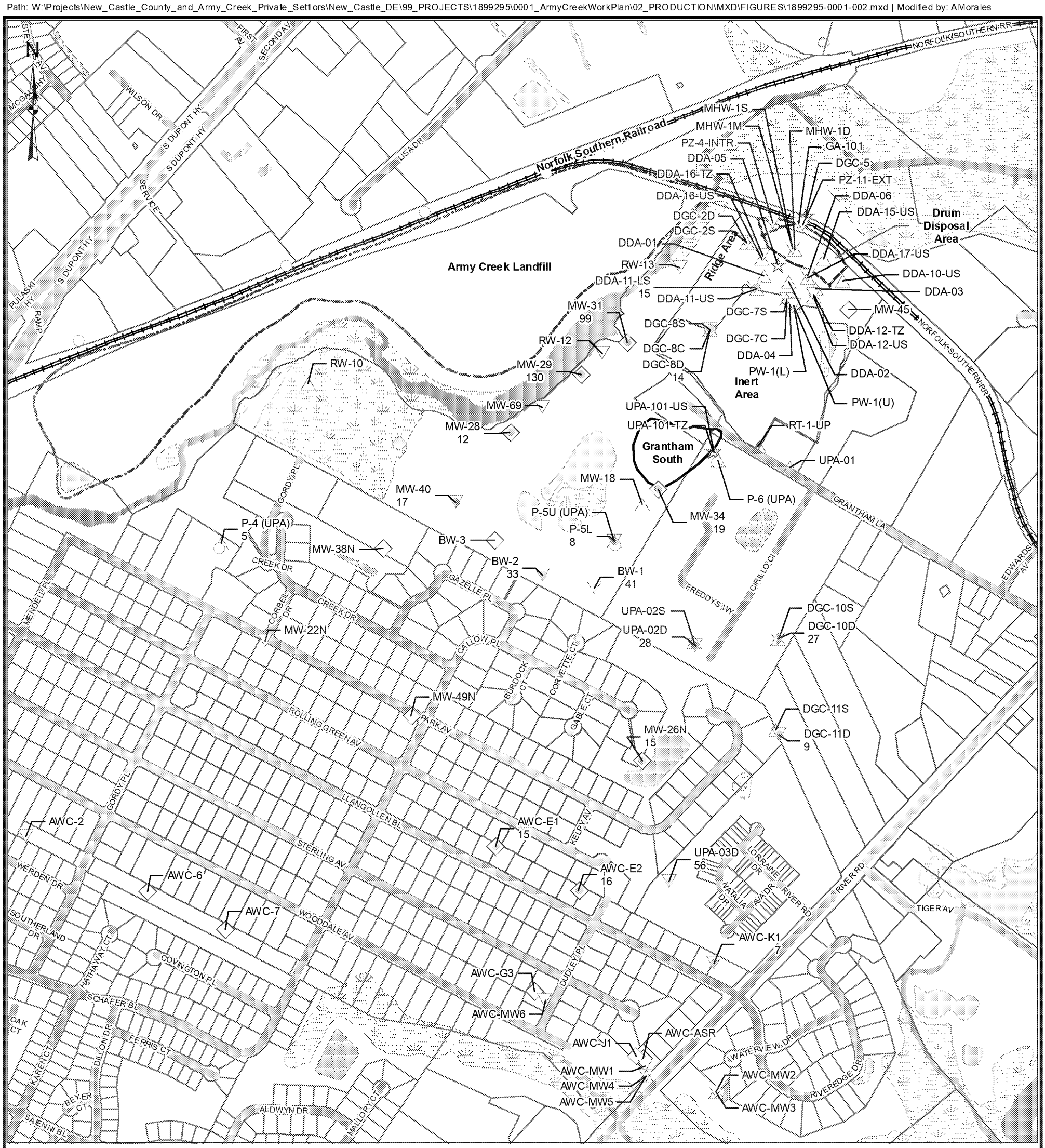


LEGEND

PFOS DETECTIONS

- < 40
- 40 - 70
- 70 - 130
- WELL SCREENED IN UPCU TRANSITION ZONE
- WELL SCREENED IN UPA UPPER SAND
- WELL SCREENED IN UPA LOWER SAND
- WELL SCREENED ACROSS UPA UPPER SAND AND LOWER SAND
- WELL SCREENED IN COLUMBIA AQUIFER
- 23 PFOS CONCENTRATIONS (ng/L)

REFERENCE

Base data from New Castle County Delaware, Department of Land Use, "eParcel View Map" web site GIS data download. Data acquired 01/18/2012.

PFOA = Perfluorooctanoic Acid
ng/L = Nanograms per Liter
* Indicates data not used for contouring

0 300 600 1,200 Feet

FIGURE 2-4

REVIEW		
CHECK		
GIS	AM	11/2/2018
DESIGN	BAR	11/2/2018
REV. 0	SCALE: AS SHOWN	
FILE No.	1899295-0001-002	
PROJECT No.	013-6052.007	

TITLE

PFOS
UPA LOWER SAND
APRIL 2017

PROJECT

Army Creek Landfill Superfund Site
New Castle, Delaware

GOLDER

ATTACHMENT 3

AVAILABLE BORING AND MONITORING WELL LOGS

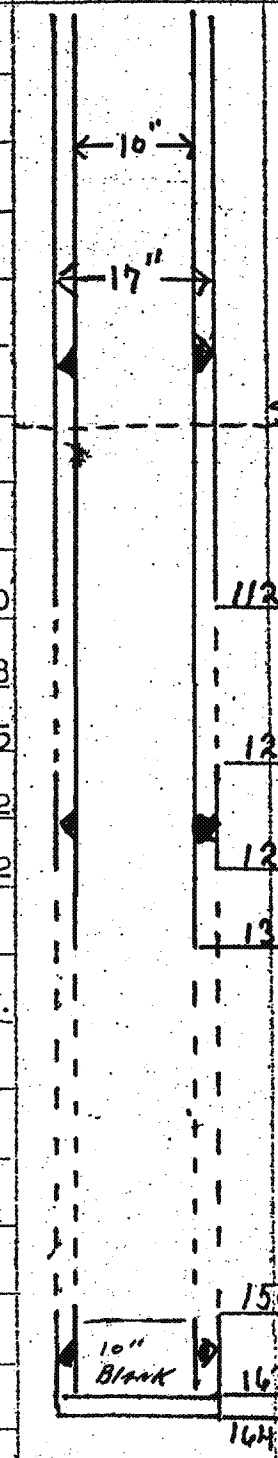
Well Filled To 154.'
Very Fine To Coarse & Gravel

ARTESIAN WATER COMPANY
Newark, Delaware

WELL REPORT

Test Well [ ] Completed Well [X]

Formation Log	Depth in ft. (from G.L.)
TOP SOIL AND CLAY	2-12
SANDY CLAY AND STONES	12-36
SANDY CLAY	36-64
DIRTY SAND AND GRAVEL	64-66
SANDY CLAY	66-70
dirty sand and clay	70-73
CLEAN SAND AND GRAVEL	73-77
SANDY CLAY	77-112
DIRTY FINE SAND	112-120
SANDY CLAY	120-128
DIRTY SAND AND CLAY	128-135
CLEAN FINE SAND	135-142
DIRTY FINE SAND	142-152
sandy clay	
Pump	
14-10'-S 140	
2-5'-S 10	
Pump 4'-2½ 4-2½	
Section 1-6 1-6	
155-8½	
Pump Sanded in 18''	



Well No: 2 Permit No: N/A

Location: LLAGOLLEN
(Draw well location sketch on reverse side.)

Date completed: NOVEMBER 1953

Drilled by: KELLY WELL CO.

Drilling Method: REVERSE ROTARY

Sonic Log [ ] Gamma Log [ ]
74'-57

Pump Test Data

Ground Elvn: 11.53' 56' Hrs. Develd:
8-26-76

Static Level: 83.97 Pmp. Level:
74.57 - 8-18-76

Pmp. Rate (GPM): Hrs. Pmpd:

Water Quality Data

Color: Turbidity:

pH: Iron:

Hardness: Chloride:

Remarks

Excellent [ ] Good [ ] Bad [ ]

Estimated Capacity (GPM):

Reported by:

Date of report:

Well Installation As-Built

Summary Table

Location: LIANGOLLEN

Well Name: 6R

Date: 12/11/17

Pump: GOULDS — *Manufacturer* — 8RJHC(2 STAGE) — *Model*

Motor: FRANKLIN — *Manufacturer* — 2366178125 — *Model*

Design Flow: 600 Design TDH: 180

18 Diam. (in) — STEEL Material — *Outer Casing*

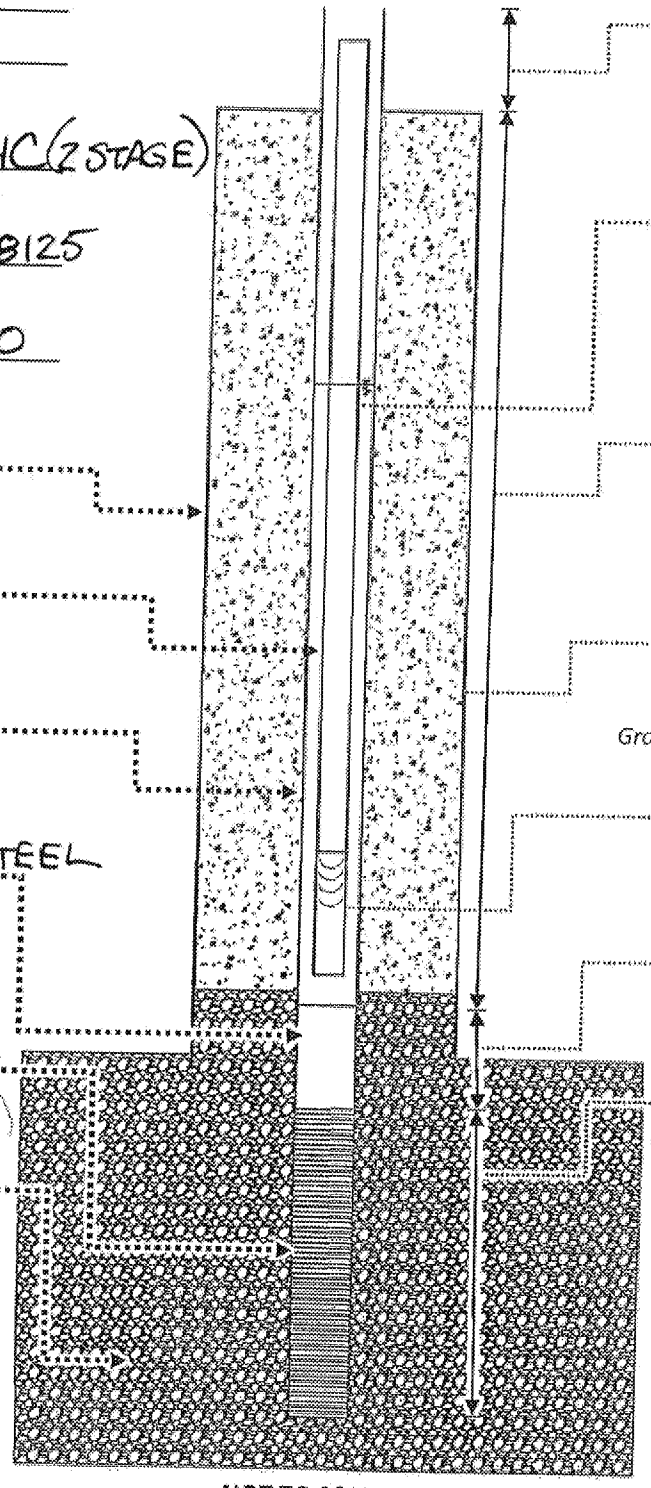
6 Diam. (in) — STEEL Material — *Column Pipe*

12 Diam. (in) — STEEL Material — *Inner Casing*

12 Diam. (in) — STAINLESS STEEL Material — *Blank*

12 Diam. (in) — STAINLESS STEEL Material — *Screen*

24 Diam. (in) — #2 GRAVEL Size — *Gravel Pack*



2 Length (ft) *Inner Casing TOC to Ground*

95 Length (ft) *Column Pipe*

100 Length (ft) *Inner Casing Ground to Top of Blank*

100 Length (ft) *Outer Casing Ground to Bottom of Casing*

104 Pump Setting (ft) *TOC to Pump Intake*

5 Length (ft) *Blank*

40 Length (ft) *Screen*

NOT TO SCALE

Notes

SCREEN .040

LAYNE-NEW YORK CO., INC.

2/3/69

1250 WEST ELIZABETH AVE., LINDEN, N. J.

LOG OF WELL

Well No. 7 Job No. M129-68 Test No.

Log of Well for (Owner) Artesian Water Co.

Address 501 Newport Gap Pike, Newport, Wilmington, Del.

Representative, if any

Well Located at Llangolen Estates in Newcastle County, State of Del.

Furnish sketch of location Date Drilling started Date Test Hole Completed

Total depth to bottom of Well 180' Diameter Test Hole Elevation at Ground Level, if available

Elevation at Ground Level, if available Distance from where measurements were taken to ground level 0'

Water stands when not pumping feet inches from the surface of the ground

All Measurements taken from Ground level

THICKNESS OF STRATUM	DEPTH TO BOTTOM OF STRATA	Length of Core Taken	FORMATION FOUND EACH STRATUM	THICKNESS OF STRATUM	DEPTH TO BOTTOM OF STRATA	Length of Core Taken	FORMATION FOUND EACH STRATUM
1	1		Top soil		171		Fine yellow sand light streaks of white clay
4	5		Hard dry clay & sand mixed with gravel & boulders		180		Sand, gray clay
21	26		Fine to coarse sand & gravel & white clay streaks				
4	30		Yellow clay				
14	44		Red clay				
	76		Sandy red clay & light streaks of sand				
18	94		Tough red clay				
3	97		Red sandy clay & hard streaks of sand				
	137		Hard packed fine to medium yellow sand				
4	141		Clay				
	150		Fine to coarse yellow, hard packed sand				

Remarks and opinion of Test

CHECK TYPE OF RIG USED { Reverse Rotary, Cable Tool, Wash, Other?

R. E. Errickson
Driller

LLANGOLEN WELLFEILD

WELL#7 FORMATION LOG

0-1' TOP SOIL

1-5' HARD DRY SANDY CLAY MIXED WITH GRAVEL & BOULDERS

5-26' FINE TO COARSE SAND & GRAVEL & STREAKS OF WHITE CLAY

26-30' YELLOW CLAY

30-44' RED CLAY

44-76' SANDY RED CLAY & LIGHT STREAKS OF SAND

76-94' TOUGH RED CLAY

94-97' RED SANDY CLAY & HARD STREAKS OF SAND

97-137' HARD PACKED FINE TO MEDIUM YELLOW SAND

137-141' CLAY

141- 150' FINE TO COARSE YELLOW HARD PACKED SAND

150-171' FINE YELLOW SAND & LIGHT STREAKS OF WHITE CLAY

171-180' SAND & GRAY CLAY

Pump.
JACU 221. 8BT/624
6x8x1 Head.
S# 2B722061
open Impeller-

A.C. SCHULTES OF MARYLAND, INC.

8221 Cloverleaf Dr., Millersville, MD 21108

Telephone 410-841-6710
Fax # 410-841-6711

Driller's Log

Water Well Contractors

CUSTOMER: Artesian Water Company JOB H6335

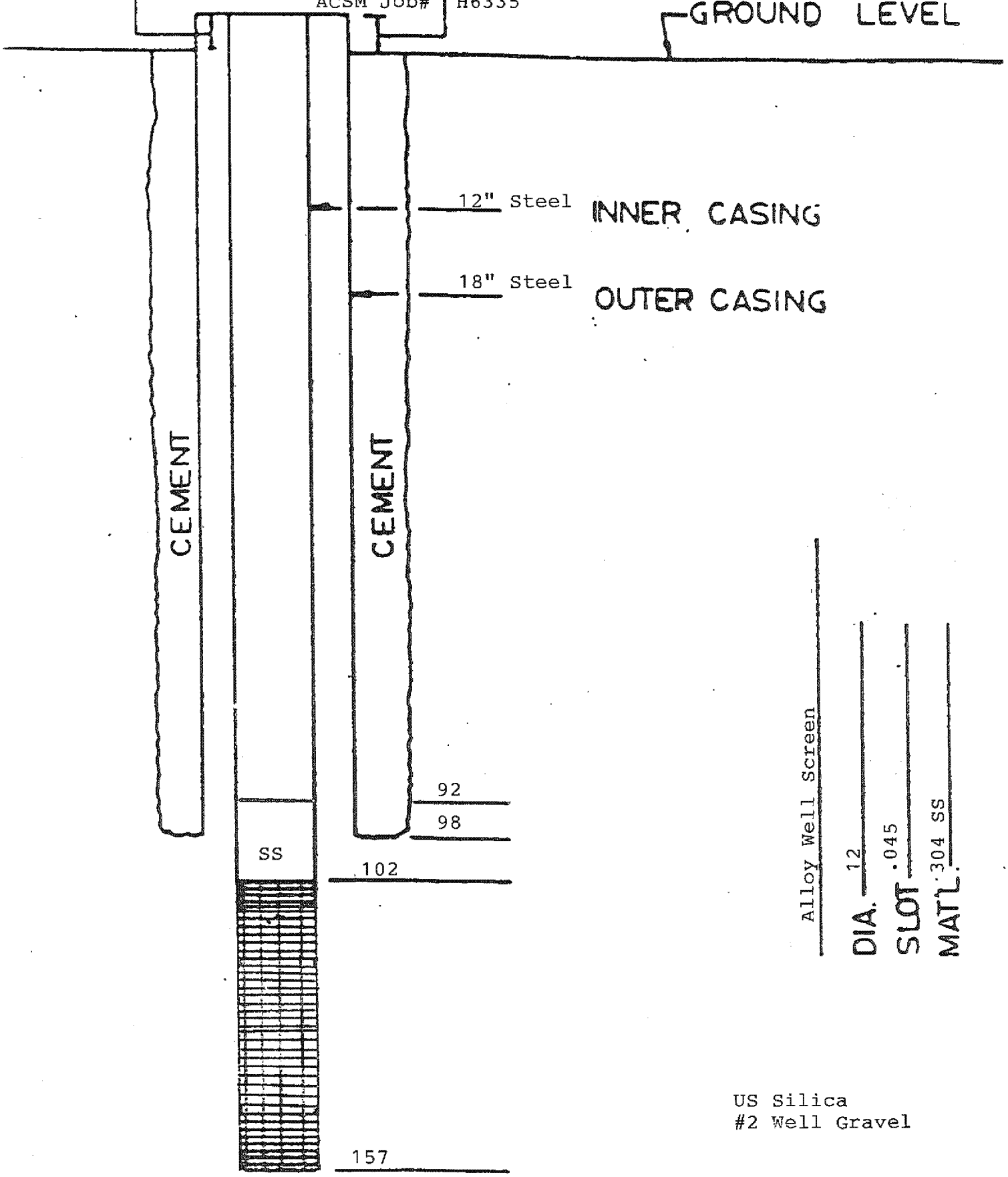
ADDRESS: DUDLEY PL. DATE 10/10/12

LOCATION: NEW CASTLE, DE PERMIT NO. 240617

		FEET FROM GROUND SURFACE 0 TO _____	WELL LOG
GROUND		0-1	Top soil
TOTAL DEPTH	CASING	1-8	COARSE TO MED SAND W/ SOME PEE GRAVEL
		8-90	MULTI-COLORED CLAY MAINLY RED
		90-91	HARD LAYER
		90-98	MULTICOLORED CLAY W/ SAND
		98-156	COARSE TO MED SAND W/ GRAVEL
		156-162	MED TO FINE SAND W/ SOME MICA
	SCREEN		
			PILOT HOLE

WELL NO. G-3R	DIAMETER OF WELL _____	DEPT. OF WELL _____
HOURS PUMPED _____	SLOT SIZE _____	TYPE OF CASING _____
CAPACITY GPM _____	DRILLING MACHINE NO. CF-15	LENGTH OF CASING _____
STATIC LEVEL _____	DRILLER R. MELSON	DISTANCE TO TOP OF SCREEN --
PUMPING LEVEL _____	GRAVEL _____	TYPE SCREEN _____
SPECIFIC CAPACITY _____	_____ BAGS OF _____	SIZE OF SCREEN _____
PUMPED WITH _____	DATE WELL COMPLETED _____	OUTER CASING SIZE _____
DEPTH OF GROUT _____	DRILLER'S HELPER _____	OUTER CASING DEPTH _____
DEPTH GRAVEL PACKED _____		

Proposed Well Design
Artesian Water Company
Llangollen G3R
ACSM Job# H6335



PERMIT 240617

TETRA TECH INC. WELL DRILLING LOG	PERMIT NO. SHEET: 1 of 1
PROJECT: Army Creek	PROJECT NO. 0151-06
WELL DESIGNATION: BW-1	DATE(S) DRILLED: 4/25/94-4/29/94
DRILLING CONTRACTOR: Walton Corporation	DRILLING METHOD: Mud Rotary
BORING DIAMETER: 14" to 46'; 10"46' to 126.5'	SAMPLING METHOD: Drill Cuttings
SAMPLING INTERVAL: Continuous	TOTAL DEPTH: 126.5'
LOGGED BY: C. W. Geiger	
SCREENED SIZE AND MATERIAL: 4" Schedule 40 PVC, 0.020" slots	SCREENED INTERVAL: 126.5'-106.5'
CASING SIZE AND MATERIAL: 4" Schedule 40 PVC	CASED INTERVAL: 106.5' - +3' above ground
GRAVEL PACK SIZE: #2 Morie Sand	PACKED INTERVAL: 126.5'-101'
GROUT TYPE: Cement-Bentonite	GROUTED INTERVAL: 97'-0
GROUTING METHOD: Pressure	BENTONITE SEAL: 101'-97'
DEVELOPMENT METHOD: Air Surging/Jetting TIME: 70 minutes	ESTIMATED YIELD: 75 gpm
STATIC WATER DEPTH: DATE: 5/06/94	REFERENCE:
REMARKS:	

SAMPLE INTERVAL (feet)		LITHOLOGIC INTERVAL (feet)		HEADSPACE READING (units)	SPOON BLOWS	RECOVERY	CLASSIFICATION OF MATERIAL
From	To	From	To				
NA	NA	0	6	NA	NA	NA	Gravel fill.
NA	NA	6	22	NA	NA	NA	Orange-brown, fine to medium sand/trace silt.
NA	NA	22	35	NA	NA	NA	Orange-white coarse sand with thin layers of gray, white silty clay.
NA	NA	35	48	NA	NA	NA	Gray clay with wood; some silt.
NA	NA	48	59	NA	NA	NA	Red-white variegated clay.
NA	NA	59	61.5	NA	NA	NA	Gray clay with some gravel, silt and coarse sand.
NA	NA	61.5	68.5	NA	NA	NA	Dark gray clay with silt; trace coarse sand.
NA	NA	68.5	85	NA	NA	NA	Yellow-green silty clay with trace sand.
NA	NA	85	96	NA	NA	NA	Fine-medium brown sand w/little white & red clay & silt.
NA	NA	96	108	NA	NA	NA	Red and white silt and clay.
NA	NA	108	113	NA	NA	NA	Brown fine to medium sand with mica.
NA	NA	113	124	NA	NA	NA	White medium to coarse sand with mica; some gravel.
NA	NA	124	126.5	NA	NA	NA	White clay.

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TETRA TECH INC. WELL DRILLING LOG	PERMIT NO. SHEET: 1 of 1
PROJECT: Army Creek	PROJECT NO. 0151-06
WELL DESIGNATION: BW-2	DATE(S) DRILLED: 5/2/94-5/5/94
DRILLING CONTRACTOR: Walton Corporation	DRILLING METHOD: Mud Rotary
BORING DIAMETER: 14" to 40'; 10"40' to 125'	SAMPLING METHOD: Drill Cuttings
SAMPLING INTERVAL: Continuous	TOTAL DEPTH: 125'
LOGGED BY: C. W. Geiger	
SCREENED SIZE AND MATERIAL: 4" Schedule 40 PVC, 0.020" slots	SCREENED INTERVAL: 125'-105'
CASING SIZE AND MATERIAL: 4" Schedule 40 PVC	CASED INTERVAL: 105'- +3' above ground
GRAVEL PACK SIZE: #2 Morie Sand	PACKED INTERVAL: 125'-100'
GROUT TYPE: Cement-Bentonite	GROUTED INTERVAL: 95'-0
GROUTING METHOD: Pressure	BENTONITE SEAL: 100'-95'
DEVELOPMENT METHOD: Air Surging/Jetting TIME: 75 minutes	ESTIMATED YIELD: 35 gpm
STATIC WATER DEPTH: DATE: 5/06/94	REFERENCE:
REMARKS:	

SAMPLE INTERVAL (feet)		LITHOLOGIC INTERVAL (feet)		HEADSPACE READING (units)	SPOON BLOWS	RECOVERY	CLASSIFICATION OF MATERIAL
From	To	From	To				
NA	NA	0	6	NA	NA	NA	Brown fine to medium sand w/silt.
NA	NA	6	12	NA	NA	NA	White medium to coarse sand with some silt
NA	NA	12	16	NA	NA	NA	Fine to medium brown sand with silt.
NA	NA	16	23.5	NA	NA	NA	Coarse brown sand with silt ne gravel.
NA	NA	23.5	25	NA	NA	NA	Orange-red, gray clay with some sand.
NA	NA	25	35	NA	NA	NA	Gray clay, with silt; thin iron ore layer at 30.5'.
NA	NA	35	55	NA	NA	NA	Red/white variegated clay.
NA	NA	55	62.5	NA	NA	NA	Gray clay with little silt.
NA	NA	62.5	63.5	NA	NA	NA	Iron ore and yellow silty clay.
NA	NA	63.5	75	NA	NA	NA	Yellow-brown silty clay.
NA	NA	75	80	NA	NA	NA	White silty clay; trace fine sand.
NA	NA	80	85	NA	NA	NA	Brown very fine sand, trace silt.
NA	NA	85	87	NA	NA	NA	Orange-brown, fine to medium sand; trace silt.
NA	NA	87	105	NA	NA	NA	Red, white, yellow silt.
NA	NA	105	113	NA	NA	NA	Brown fine to coarse sand; trace silt.
NA	NA	113	125	NA	NA	NA	White medium to coarse sand with some gravel.
NA	NA	125	126	NA	NA	NA	White clay.

J:\wpdata\0151\misc\wl-drl.log

TETRA TECH INC. WELL DRILLING LOG	PERMIT NO. SHEET: 1 of 1
PROJECT: Army Creek	PROJECT NO. 0151-06
WELL DESIGNATION: BW-3	DATE(S) DRILLED: 5/11/94-5/18/94
DRILLING CONTRACTOR: Walton Corporation	DRILLING METHOD: Mud Rotary
BORING DIAMETER: 14" to 32'; 10" to 135'	SAMPLING METHOD: Drill Cuttings
SAMPLING INTERVAL: Continuous	TOTAL DEPTH: 135'
LOGGED BY: C. W. Geiger	
SCREENED SIZE AND MATERIAL: 4" Schedule 40 PVC, 0.020" slots	SCREENED INTERVAL: 135'-50'
CASING SIZE AND MATERIAL: 4" Schedule 40 PVC	CASED INTERVAL: 50'- +3' above ground
GRAVEL PACK SIZE: #2 Morie Sand	PACKED INTERVAL: 135'-47'
GROUT TYPE: Cement-Bentonite	GROUTED INTERVAL: 44'-0
GROUTING METHOD: Pressure	BENTONITE SEAL: 47'-44'
DEVELOPMENT 'HOD: Surging/Air Lifting TIME: 180 minutes	ESTIMATED YIELD: 25 gpm
STATIC WATER DEPTH: DATE: 6/06/94	REFERENCE:
REMARKS:	

SAMPLE INTERVAL (feet)		LITHOLOGIC INTERVAL (feet)		HEADSPACE READING (units)	SPOON BLOWS	RECOVERY	CLASSIFICATION OF MATERIAL
From	To	From	To				
NA	NA	0	20.5	NA	NA	NA	Organic matter, fine to coarse sand with some silt and gravel.
NA	NA	20.5	29.5	NA	NA	NA	Gray silty clay.
NA	NA	29.5	50	NA	NA	NA	Red/white clay.
A	NA	50	120	NA	NA	NA	Brown, very fine to medium sand.
NA	NA	120	128	NA	NA	NA	Gray/black coarse sand.
NA	NA	128	133	NA	NA	NA	White-yellow silt.
NA	NA	133	137	NA	NA	NA	White/red clay.

f:\wpdata\0151\misc\wl-dril.log

DUNN GEOSCIENCE CORPORATION LATHAM, NEW YORK (518) 783-8102	TEST BORING LOG	BORING NO. DGC-10d

PROJECT	Delaware Sand and Gravel Landfill RI
CLIENT	DNREC, State of Delaware
DRILLING CONTRACTOR	Warren George, Inc.
PURPOSE	Monitoring Well Installation -- Phase II

SHEET 1 OF 8	
JOB NO.	560-2-4453
ELEVATION	40.16' amsl
DATUM	land surface
DATE STARTED	3-11-86
DATE FINISHED	3-18-86
DRILLER	T. Tirro
INSPECTOR	Glen Combes/Duane Wanty

GROUNDWATER					CASING	SAMPLE	CORE
DATE	TIME	DEPTH	CASING	TYPE	Mud Rot.	Split Spoon	N/A
				DIAMETER	8"	2"	
				WEIGHT		300#	
				FALL		30"	

DEPTH FT.	CASING BLOWS	SAMPLE NUMBER	BLOWS ON SAMPLE SPOON PER 6"	UNIFIED CLASSI-FICATION	GRAPHIC LOG	IDENTIFICATION	REMARKS
		S-1	3, 3, 4, 6	MH		Rd Br & Gr $&C; iron staining	Rec = 1.2 Moist
5		S-2	3, 4, 4, 4	MH		Rd Br & Gr Cy$; iron staining	Rec = 1.5 Moist
						Red Brown SILT and CLAY; iron staining	
10		S-3	3, 2, 3, 4	CH		Gr & Rd Br C&$; seam Lt Gr $; iron staining	Rec = 1.8 Moist
						Driller States G @ 13'-15' (COLUMBIA)	
15		S-4	3, 4, 5, 7	CL		0-0.2' mf(+)G (UPPER POTOMAC) 0.2-0.5 Rd Br C&$ t(-), cS, t(-)mG; iron staining	Rec = 0.5 Moist
20							

DUNN GEOSCIENCE CORPORATION LATHAM, NEW YORK (518) 783-8102	TEST BORING LOG	BORING NO. DGC-10d
PROJECT Delaware Sand and Gravel Landfill RI		SHEET 2 OF 8
CLIENT DNREC - State of Delaware		JOB NO. 560-2-4453

DEPTH FT.	CASING BLOWS	SAMPLE NUMBER	BLOWS ON SAMPLE SPOON PER 6"	UNIFIED CLASSI-FICATION	GRAPHIC LOG	IDENTIFICATION	REMARKS
20		S-5	5 5 8 9	CH		Gr& Br $yC; frqt pkts Gr $&C; variegated	Rec = 1.1 Moist
25		S-6	3 4 5 6	CH		Gr & Br $yC; variegated	Rec = 0.5 Moist
30		S-7	4 5 7 9	CH		Gr & Rd $yC t(-), mS; occ pkts Gn Br C&$	Rec = 1.3 Moist used 3" spoon
35		S-8	3 3 8 13	CH		Gr & Rd & Yw C&$; variegated	Rec = 1.5 Moist used 3" spoon
40		S-9	3 5 8 11	CH		Rd & Gr C&$ t(-), mS; variegated	Rec = 1.6 Moist used 2" spoon
45							

DUNN GEOSCIENCE CORPORATION LATHAM, NEW YORK (518) 783-8102	TEST BORING LOG	BORING NO. DGC-10d
PROJECT Delaware Sand and Gravel Landfill RI		SHEET 3 OF 8
CLIENT DNREC, State of Delaware		JOB NO. 560-2-4453

DEPTH FT.	CASING BLOWS	SAMPLE NUMBER	BLOWS ON SAMPLE SPOON PER 6"	UNIFIED CLASSI-FICATION	GRAPHIC LOG	IDENTIFICATION	REMARKS
45		S-10	5 6 10 10	CH		Rd & Gr $yC; occ pkts mf(-)S; variegated	Rec = 1.5 Moist used 2" spoon
50		S-11	3 4 6 7	CH		Gr & Rd $yC t(-), mS; variegated	Rec = 1.6 Moist used 2" spoon
						Gray and Red CLAY and SILT trace(-), medium SAND; variegated	
55		S-12	5 5 10 11	CH		Gr & Rd C&$ t(-), mS; occ pkt Gr Cy$; variegated	Rec = 1.8 Moist used 2" spoon
60		S-13	4 5 7 8	CH		Rd & Gr C&$; 1yr Gr$; occ pkt Gr Cy$; variegated	Rec = 2.0 Moist used 2" spoon
65		S-14	5 7 13 14	CH		Gr & Ppl & Gn Br C&$; pkt Gr $&C; variegated	Rec = 2.0 Moist used 2" spoon
70							

DUNN GEOSCIENCE CORPORATION LATHAM, NEW YORK (518) 783-8102	TEST BORING LOG	BORING NO. DGC-10d
PROJECT Delaware Sand and Gravel Landfill RI		SHEET 4 OF 8
CLIENT DNREC, State of Delaware		JOB NO. 560-2-4453

DEPTH FT.	CASING BLOWS	SAMPLE NUMBER	BLOWS ON SAMPLE SPOON PER 6"	UNIFIED CLASSIFICATION	GRAPHIC LOG	IDENTIFICATION	REMARKS
70		S-15	4 6 12 9	MH		Gr Br $&C; variegated	Rec = 2.0 WET used 2" spoon
75		S-16	5 6 9 10	CH		Rd Br & Gn Br & Gr C&$; frqt prts Gr $; variegated	Rec = 2.0 Moist used 2" spoon
80		S-17	6 7 10 11	CH		Rd & Gr $yC; frqt prts Gr $	Rec = 2.0 Moist used 2" spoon
85		S-18	9 50/.3	MH		Gr $&C; silt nodules	Rec = 0.9 Moist used 2" spoon
90		S-19	6 8 11 15	CH SP		0-1.3' Dk Gr C&$; frqt seams Gr Cy$ 1.3'-2.0' Gr vfS, s$	Rec = 2.0 WET used 2" spoon
95							

DUNN GEOSCIENCE CORPORATION LATHAM, NEW YORK (518) 783-8102	TEST BORING LOG	BORING NO. DGC-10d
PROJECT Delaware Sand and Gravel Landfill RI		SHEET 5 OF 8
CLIENT DNREC, State of Delaware		JOB NO. 560-2-4453

DEPTH FT.	CASING BLOWS	SAMPLE NUMBER	BLOWS ON SAMPLE SPOON PER 6"	UNIFIED CLASSI-FICATION	GRAPHIC LOG	IDENTIFICATION	REMARKS
95		S-20	9 7 11 12	CH SM		0-1.3' Dk Gr C&$, frqt seam Dk Gr Cy$ 1.3-2.0' Dk Gr vf S, 1(+)$; frqt prts Dk Gr C&$	Rec = 2.0 WET used 2" spoon
100		S-21	5 6 8 15	SP		Dk Gr vf S, 1(-)$, frqt seams Dk Gr C&$	Rec = 2.0 WET used 2" spoon
105		S-22	6 7 11 12	MH SM		0-0.7' Gr $&C; frqt prts Gr C&$ 0.7-2.0' Gr vfS, s$; occ seams Gr $&C	Rec = 2.0 WET used 2" spoon
110			5 9 13 50	SP		0-0.2 Gr C&S 0.2-2.0 Rd & Yw & Or vfS, 1$; frqt seams Lt Gr $yC; occ seam iron stone; occ lyr Rd & Gr C&$; iron staining	Rec = 2.0 Moist used 2" spoon
115			32 23 12 12	SP		Yw & Or & Wh f S; seam Lt Gr $yC	Rec = 1.0 WET used 2" spoon
120						Yellow and Gray fine SAND; layers Gray SILT and CLAY	

DUNN GEOSCIENCE CORPORATION LATHAM, NEW YORK (518) 783-8102	TEST BORING LOG	BORING NO. DGC-10d
PROJECT Delaware Sand and Gravel Landfill RI		SHEET 6 OF 8
CLIENT DNREC, State of Delaware		JOB NO. 560-2-4453

DEPTH FT.	CASING BLOWS	SAMPLE NUMBER	BLOWS ON SAMPLE SPOON PER 6"	UNIFIED CLASSIFICATION	GRAPHIC LOG	IDENTIFICATION	REMARKS
120		S-25	10 14 15 17	CH		Lt Gr & Rd $yC; occ pkt Lt Gr $&C; variegated	Rec = 2.0 Moist used 2" spoon
						Light Gray and Red Silty CLAY; variegated	
125		S-26	6 15 37 50	CH SP		0-0.7' Rd & Gr & Yw $yC; variegated 0.7-1.5 Or & Yw & Lt Gr vf S, 1(-)$; occ prts Lt Gr C	Rec = 1.5 used 2" spoon
130		S-27	16 19 23 20	SP		Lt Gr Wh fS; low angle bedding	Rec = 1.3 WET 300# hammer
135		S-28	13 15 18 17	SP		Lt Gr Wh c(-)m(-)f(+)S; planar bedding; 1yr Yw cmS at bottom	Rec = 1.4 WET 300# hammer
140		S-29	13 21 25 22	SP		Lt Gr & Lt Or m(-)f(+)S, t Cy$; planar and low angle bedding	Rec = 1.2 WET 300# hammer
145							

DUNN GEOSCIENCE CORPORATION LATHAM, NEW YORK (518) 783-8102	TEST BORING LOG	BORING NO. DGC-10d
PROJECT Delaware Sand and Gravel Landfill RI		SHEET 7 OF 8
CLIENT DNREC, State of Delaware		JOB NO. 560-2-4453

DEPTH FT.	CASING BLOWS	SAMPLE NUMBER	BLOWS ON SAMPLE SPOON PER 6"	UNIFIED CLASSIFICATION	GRAPHIC LOG	IDENTIFICATION	REMARKS
145						Light Gray fine SAND, trace Clayey SILT	Switched to 10' sampling; approved by WJM
150		S-30	25 28 37 50/.4	SM		Lt Gr vfS; lyrs Lt Gr Wh C	Rec = 1.7 WET 300# hammer
155							
160		S-31	36 50/.4	SP		Lt Gr & Lt Gn & Yw f S, t (-) Cy$	Rec = 0.5 WET 300# hammer
165							
170						(UPPER POTOMAC) ------?----?-----?-----?-----?-----?--- (MIDDLE POTOMAC)	

DUNN GEOSCIENCE CORPORATION LATHAM, NEW YORK (518) 783-8102	TEST BORING LOG	BORING NO. DGC-10d
PROJECT Delaware Sand and Gravel Landfill RI		SHEET 8 OF 8
CLIENT DNREC, State of Delaware		JOB NO. 560-2-4453

DEPTH FT.	CASING BLOWS	SAMPLE NUMBER	BLOWS ON SAMPLE SPOON PER 6"	UNIFIED CLASSI-FICATION	GRAPHIC LOG	IDENTIFICATION	REMARKS
170		S-32	5 10 12 15	CL CH		0-1.1' Gr & Yw & Rd C&$ 1(-), c(-)m(-) f(+)S, t(-) mfG ----------171.1 feet---------- 1.1-2.0' Dk Gr & Rd C; variegated	Rec = 2.0 Moist 300# hammer
						Gray and Red Silty CLAY; variegated	
						E.O.B. 172' Lockable Steel Protective Casing Grout (cement and bentonite) Bentonite Seal Sand Pack (Morie #1) Sand Fill and Cuttings	 0-123' 123-126' 126-140' 140-172'
						Stick up (PVC) Riser (sch. 40, flush joint, 4"ID PVC) Screen (sch.40, flush joint, 4"ID, 10 slot PVC)	1.95' +1.95 - 128' 128 - 138'

DUNN GEOSCIENCE CORPORATION LATHAM, NEW YORK (518) 783-8102	TEST BORING LOG	BORING NO.
PROJECT	Delware Sand and Gravel Landfill RI	DGC-10s
CLIENT	DNREC, State of Delaware	SHEET 1 OF 1
DRILLING CONTRACTOR	Warren George, Inc.	JOB NO. 560-2-4453
PURPOSE	Monitoring Well Installation - Phase II	ELEVATION 40.24' amsl

GROUNDWATER					CASING	SAMPLE	CORE	
DATE	TIME	DEPTH	CASING	TYPE	Mud Rot	N/A	N/A	DATUM land surface
				DIAMETER	8"			DATE STARTED 3-18-86
				WEIGHT				DATE FINISHED 3-20-86
				FALL				DRILLER Tony Tirro
								INSPECTOR Duane A. Wanty

DEPTH FT.	CASING BLOWS	SAMPLE NUMBER	BLOWS ON SAMPLE SPOON PER 6"	UNIFIED CLASSI-FICATION	GRAPHIC LOG	IDENTIFICATION	REMARKS
							no sampling
						E.O.B. 115'	
						Lockable steel protective casing	
5						Grout (cement and bentonite)	0-88'
						Bentonite seal	88-91'
						Sand pack (Morie #1)	91-115'
						Stick up (PVC)	2.04'
10						Riser (sch. 40, flush joint, 4" ID PVC)	+2.04 - 93'
						Screen (sch. 40, flush joint, 4" ID, 10 slot PVC)	93 - 113'
15							
20							

DUNN GEOSCIENCE CORPORATION LATHAM, NEW YORK (518) 783-8102	TEST BORING LOG	BORING NO. DGC-11d

PROJECT	Delaware Sand and Gravel Landfill RI	
CLIENT	DNREC, State of Delaware	SHEET 1 OF 8
DRILLING CONTRACTOR	Warren George, Inc.	JOB NO. 560-2-4453
PURPOSE	Monitoring Well Installation - Phase II	ELEVATION 37.33' amsl

GROUNDWATER					CASING	SAMPLE	CORE	DATUM land surface
DATE	TIME	DEPTH	CASING	TYPE	Mud Rot.	SS	N/A	DATE STARTED 3-3-86
				DIAMETER		2"		DATE FINISHED 3-7-86
				WEIGHT		140#&300#		DRILLER Tony Tirro
				FALL		30"		INSPECTOR Duane Wanty

DEPTH FT.	CASING BLOWS	SAMPLE NUMBER	BLOWS ON SAMPLE SPOON PER 6"	UNIFIED CLASSI-FICATION	GRAPHIC LOG	IDENTIFICATION	REMARKS
		S-1	2, 2, 3, 5	CH		0-0.2 Dk Br Cy$ [A-Horizon; topsoil] 0.2-0.75 Br & Or Br $yC+, cmS, +fG	Rec = 0.75' Moist
						Brown and Orange Brown CLAY & SILT trace, course to fine SAND, trace fine GRAVEL	
5		S-2	7, 11, 12, 13	CL		Br & Or Br $&Ct, cmfS, tfG	Rec = 1.5' Moist
						Driller noted thin Gravel layer at 8'	
10		S-3	14, 18, 16, 15	SW		Or c(-) m(-)f(±)S, 1 Cy$, t(±)mfG	Rec = 1.2' Moist
						Orange coarse to fine SAND, little Clayey SILT, and coarse to fine GRAVEL	
15		S-4	20, 18, 7, 8	GW		Or cmfG a(+), mfS, 1 Cy$	Rec = 0.1' (uncohesive) WET
						(COLUMBIA) Driller noted clay at 18' (UPPER POTOMAC)	
20							

DUNN GEOSCIENCE CORPORATION LATHAM, NEW YORK (518) 783-8102	TEST BORING LOG	BORING NO. DGC-11d

PROJECT Delaware Sand and Gravel Landfill RI — SHEET 2 OF 8

CLIENT DNREC, State of Delaware — JOB NO. 560-2-4453

DEPTH FT.	CASING BLOWS	SAMPLE NUMBER	BLOWS ON SAMPLE SPOON PER 6"	UNIFIED CLASSI-FICATION	GRAPHIC LOG	IDENTIFICATION	REMARKS
20		S-5	6 12 19 22	CH		Rd & Lt Gr Wh C; variegated	Rec = 0.3' Moist
25		S-6	4 4 9 9	CH		Rd & Lt Gr Wh C; variegated	Rec = 1.1' Moist
30		S-7	6 8 13 11	CH		Rd & Lt Gr Wh C; variegated	Rec = 1.5' Moist
35		S-8	11 16 30 23	CH		Lt Gr Wh $yC	Rec = 1.5' Moist
40		S-9	9 14 20 24	CH		Rd & Lt Gr Wh C; variegated	Rec = 1.8' Moist
						Red & Light Gray White CLAY; variegated	
45							

DUNN GEOSCIENCE CORPORATION LATHAM, NEW YORK (518) 783-8102	TEST BORING LOG	BORING NO. DGC-11d
PROJECT Delaware Sand and Gravel Landfill RI		SHEET 3 OF 8
CLIENT DNREC, State of Delaware		JOB NO. 360-2-4453

DEPTH FT.	CASING BLOWS	SAMPLE NUMBER	BLOWS ON SAMPLE SPOON PER 6"	UNIFIED CLASSI-FICATION	GRAPHIC LOG	IDENTIFICATION	REMARKS
45		S-10	12 19 29 30	CH		Rd & Lt Gr Wh & Yw Gn C; variegated	Rec = 1.8' Moist
50		S-11	15 18 28 28	CH		Lt Gr Wh & Yw Gn C; variegated	Rec = 1.8' Moist
55		S-12	19 24 25 38	CH		Lt Gr Wh & Br & Rd & Yw Gn C; variegated	Rec = 2' Moist
60		S-13	3 5 9 8	CH		Gr C	Rec = 2' Moist 300 lb. hammer
65		S-14	6 6 8 28	CH SM		0-1.6' GrC 66.6' 1.6'-2.0' Gr vf S, a Cy$	Rec = 2.0' WET 300#

DUNN GEOSCIENCE CORPORATION LATHAM, NEW YORK (518) 783-8102	TEST BORING LOG	BORING NO. DGC-11d
PROJECT Delaware Sand and Gravel Landfill RI		SHEET 4 OF 8
CLIENT DNREC, State of Delaware		JOB NO. 560-2-4453

DEPTH FT.	CASING BLOWS	SAMPLE NUMBER	BLOWS ON SAMPLE SPOON PER 6"	UNIFIED CLASSI-FICATION	GRAPHIC LOG	IDENTIFICATION	REMARKS
70		S-15	10 21 32 33	ML		Lt Gr vfS, l(+)Cy$; lyrs Dk Gr $&C	Rec = 1.5' Moist
						Light Gray very fine SAND, and Clayey SILT	
75		S-16	22 17 20 18	SM		Lt Gr vfS, s(-)Cy$	Rec = 1.2' WET 300#
80		S-17	10 17 19 17	ML		Md Gr & Lt Gr $&C l,vfS; lyr $yC; lignite	Rec = 2.0' WET 300#
85		S-18	7 9 10 15	CH		Rd & Gr & Yw Gn C; variegated	Rec = 1.8' WET 300#
90		S-19	7 8 14 13	ML		Gr $&C	Rec = 2.0' WET
						Red & Gray SILT and CLAY	

DUNN GEOSCIENCE CORPORATION LATHAM, NEW YORK (518) 783-8102	TEST BORING LOG	BORING NO. DGC-11d
PROJECT Delaware Sand and Gravel Landfill RI		SHEET 5 OF 8
CLIENT DNREC, State of Delaware		JOB NO. 560-2-4453

DEPTH FT.	CASING BLOWS	SAMPLE NUMBER	BLOWS ON SAMPLE SPOON PER 6"	UNIFIED CLASSI-FICATION	GRAPHIC LOG	IDENTIFICATION	REMARKS
95		S-20	5 4 6 8	CH		Alt lyrs Gr C and Gr Cy$	Rec = 2.0' WET 300#
100		S-21	4 3 10 12	SP		Gr vfS, a Cy$; lyrs Dk Gr C	Rec = 1.2' WET 300#
105		S-22	9 16 13 15	CH SP		0-0.2' Gr C 0.2-1.0' Yw vfS 1.0-1.8' Rd Or vfS	Rec = 1.8' WET 300#
110		S-23	10 19 30 18	SP		Lt Or & Lt Tn vfS; t(+) Cy$	Rec = 1.2' WET 300#
115		S-24	8 9 10 10	SP		Or & Lt Rd vfs, 1 Cy$; lyrs Lt Gr Wh C	Rec = 1.7' WET 300#
120							

DUNN GEOSCIENCE CORPORATION LATHAM, NEW YORK (518) 783-8102	TEST BORING LOG	BORING NO. DGC-11d
PROJECT Delaware Sand and Gravel Landfill RI		SHEET 6 OF 8
CLIENT DNREC, State of Delaware		JOB NO. 560-2-4453

DEPTH FT.	CASING BLOWS	SAMPLE NUMBER	BLOWS ON SAMPLE SPOON PER 6"	UNIFIED CLASSI-FICATION	GRAPHIC LOG	IDENTIFICATION	REMARKS
120		S-25	50	SP		Lt Tn fS, t Cy$	Rec = 0.5' WET 300#
125		S-26	50	SP		Lt Tn fS, t Cy$	Rec = 0.5' WET 300#
130		S-27	10 11 26 34	SP		Lt. Tn & Or & Lt Gr Wh fS, t Cy$; 1yr Lt Gr Wh C	Rec = 1.6' WET 300#
135		S-28	8 19 27 36	CH SW		0-1.1 2.0 Lt Gr Wh C	Rec = 2.0' WET 300#
140		S-29	42 50	SW		Lt Gr Wh & Or cmf S, t(-)Cy$, t mfG	Rec = 0.7' WET 300#
						Light Gray White and Tan coarse (-) to fine (+) SAND, trace Clayey SILT	

DUNN GEOSCIENCE CORPORATION LATHAM, NEW YORK (518) 783-8102	TEST BORING LOG	BORING NO. DGC-11d
PROJECT Delaware Sand and Gravel Landfill, RI		SHEET 7 OF 8
CLIENT DNREC, State of Delaware		JOB NO. 560-2-4453

DEPTH FT.	CASING BLOWS	SAMPLE NUMBER	BLOWS ON SAMPLE SPOON PER 6"	UNIFIED CLASSI-FICATION	GRAPHIC LOG	IDENTIFICATION	REMARKS
145		S-30	19 17 21 19	SW		Lt Gr Wh & Gr cmfS, t Cy$, t fG; lyrs Wh C at bottom	Rec = 1.3' WET 300#
150		S-31	13 6 9 18	SP		Lt Gr Wh & Or & Lt Rd & Yw mfS, t (-) Cy$	Rec = 1.6' WET 300#
155		S-32	28 50	SP		Lt Gr Wh fS, t Cy$	Rec = 0.7' WET 300#
160		S-33	22 50	SP		Lt Gr Wh fS, t Cy$	Rec = 0.8' WET 300#
165		S-34	20 23 50	SP		Lt Gr Wh & Lt Yw mfS, t Cy$	Rec = 1.2' WET 300#
170							

DUNN GEOSCIENCE CORPORATION LATHAM, NEW YORK (518) 783-8102	TEST BORING LOG	BORING NO. DGC-11d
PROJECT Delaware Sand and Gravel Landfill RI		SHEET 8 OF 8
CLIENT DNREC, State of Delaware		JOB NO. 560-2-4453

DEPTH FT.	CASING BLOWS	SAMPLE NUMBER	BLOWS ON SAMPLE SPOON PER 6"	UNIFIED CLASSI-FICATION	GRAPHIC LOG	IDENTIFICATION	REMARKS
170		S-35	50	SW		Lt Gr Wh cmf (+) S, + Cy$, t (-) fG	Rec = 0.3' WET 300#
175		S-36	27 37 50	SP		Or Br & Lt Gr Wh & Yw fS, t Cy$ Driller hit very hard layer (basal gravel?) at 177-178.5'	Rec = 1.1' WET 300#
						(UPPER POTOMAC) (MIDDLE POTOMAC)	
180		S-37	12 16 20 21	CH		Rd & Lt Gr Wh C; Variegated	Rec = 1.6' WET 300#
						E.O.B. 180' (sampled to 182') lockable Protective steel casing Grout (cement and bentonite) Bentonite seal Sand pack (Morie #1) Sand fill and cuttings Stick up (PVC) Riser (sch. 40, flush joint, 4" ID PVC Screen (sch. 40, flush joint, 4" ID, 10 slot PVC)	0-100' 100-103' 103-115' 115-182' 1.75' +1.75 - 105' 105 - 115'

DUNN GEOSCIENCE CORPORATION LATHAM, NEW YORK (518) 783-8102	TEST BORING LOG	BORING NO. DGC-11s

PROJECT Delaware Sand & Gravel Landfill RI	
CLIENT DNREC, State of Delaware	SHEET 1 OF 1
DRILLING CONTRACTOR Warren George, Inc.	JOB NO. 560-2-4453
PURPOSE Monitoring Well Installation -- Phase II	ELEVATION 37.18' amsl
	DATUM Land Surface
	DATE STARTED 3/7/86
	DATE FINISHED 3/7/86
	DRILLER Tony Tirro
	INSPECTOR Duane A. Wanty

GROUNDWATER					CASING	SAMPLE	CORE
DATE	TIME	DEPTH	CASING	TYPE	Mud Rot	N/A	N/A
				DIAMETER	8"		
				WEIGHT			
				FALL			

DEPTH FT.	CASING BLOWS	SAMPLE NUMBER	BLOWS ON SAMPLE SPOON PER 6"	UNIFIED CLASSI-FICATION	GRAPHIC LOG	IDENTIFICATION	REMARKS
						E.O.B. 82'	
						Lockable protective steel casing	
						Grout (cement bentonite)	0 - 65'
						Bentonite Seal	65 - 68'
						Sand Pack (Morie #1)	68 - 82'
						Stick-up (PVC)	1.72'
						Riser (Sch 40, flush joint, 4"ID PVC)	+1.72 - 70'
5						Screen (Sch 40, flush joint, 4"ID 10-slot PVC)	70 - 80'
10							
15							
20							

DC 24-21

Test hole #18 11-13-72 next to RW-2

	Depth	Description
	0-2	yellow-brown medium-coarse sand (fill)
	2-3	black sandy-tarry layer
	3-4.5	yellow-brown v. coarse rounded gravel (to 1') w/ some coarse sa
UPC	4.5-8	red, white & yellow stiff clay
	8-11	yellow-yellow brn & red stiff clay
	11-25	red & white clay
	25-34	light gray dense silty clay and yellow-gray clay
UPA	34-39	buff fine-fine medium sand w/ thin stringers of white clay or silty clay and thin layers of ironstone
	39-43	iron layer on top of white clay-silty clay
dC	43-47	gray-dark gray clay
	47-52	buff fine sand w/ an overlying layer of ironstone
	52-54	white silt
	54-75	buff fine sand, mostly clean, but probably w/ some iron cementa as drilling was tough
PA	75-80	orange medium-coarse sand w/ interbedded ironstone layers
	80-90	orange-whitish orange coarse sand w/ interbedded ironstone layers
	90-95	buff-orange fine sand
	95-96	orange & white sandy clay
	97-99	white & orange coarse-v. coarse sand
	99-102	white silty clay or clayey silt
	102-128	orange-buff fine sand w/ occasional thin stringers of white
	128-131	orange coarse sand w/ ironstone layers
	131-138	yellowish & white silty, v. fine sandy clay or clayey silt
MPC	138-141	red & white clay
	141-145	red clay

Test hole #18 (cont)

Comments: The uppermost sand sequences, a fine sand w/ clay stringers (34-39) and a fine sand (47-55) have the highest apparent resistivities in the entire section. The generally coarser sand sequences — which contain no more clay — had apparent resistivities up to 200 Ω-m, and usually 100 Ω-m less that the upper fine sands. Thus, it appears that if the fluid in the upper sands is uncontaminated water (~100 μmho cm⁻¹ conductance), then the deeper sands have a fluid whose conductivity may be in the 500-1000 μmho cm⁻¹ conductivity range.

TETRA TECH INC. WELL DRILLING LOG	PERMIT NO. SHEET: 1 of 1
PROJECT: Army Creek	PROJECT NO. 0151-06
WELL DESIGNATION: MW-22N	DATE(S) DRILLED: 6/07/94-6/14/94
DRILLING CONTRACTOR: Walton Corporation	DRILLING METHOD: Mud Rotary
BORING DIAMETER: 14" to 55'; 10" to 159'	SAMPLING METHOD: Drill Cuttings
SAMPLING INTERVAL: Continuous	TOTAL DEPTH: 159'
LOGGED BY: C. W. Geiger	
SCREENED SIZE AND MATERIAL: 4" Schedule 40 PVC, 0.020" slots	SCREENED INTERVAL: 159'-139'
CASING SIZE AND MATERIAL: 4" Schedule 40 PVC	CASED INTERVAL: 139'- +3' above grade
GRAVEL PACK SIZE: #2 Morie Sand	PACKED INTERVAL: 159'-134'
GROUT TYPE: Cement-Bentonite	GROUTED INTERVAL: 128'-0
GROUTING METHOD: Pressure	BENTONITE SEAL: 134'-128'
DEVELOPMENT HOD: Surging/Air Lifting TIME: 180 minutes	ESTIMATED YIELD: 50 gpm
STATIC WATER DEPTH: DATE: 7/05/94	REFERENCE:
REMARKS:	

SAMPLE INTERVAL (feet)		LITHOLOGIC INTERVAL (feet)		HEADSPACE READING (units)	SPOON BLOWS	RECOVERY	CLASSIFICATION OF MATERIAL
From	To	From	To				
NA	NA	0	19.5	NA	NA	NA	Orange-brown fine to medium sand with some silt and gravel.
NA	NA	19.5	30	NA	NA	NA	Brown/black fine to coarse sand with gravel.
NA	NA	30	50	NA	NA	NA	Fine to medium brown sand, little gravel.
NA	NA	50	52	NA	NA	NA	Iron ore.
NA	NA	52	72	NA	NA	NA	White-red clay.
NA	NA	72	82	NA	NA	NA	Fine to coarse sand and gravel with iron ore seams.
NA	NA	82	128	NA	NA	NA	Red, white, brown silty clay with a few small fine sand and iron ore lenses.
NA	NA	128	153	NA	NA	NA	White, silty clay with small iron ore and fine sand lenses.
NA	NA	153	159	NA	NA	NA	White fine to coarse sand and gravel.
NA	NA	159		NA	NA	NA	White clay.

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TETRA TECH INC. WELL DRILLING LOG	PERMIT NO. SHEET: 1 of 1
PROJECT: Army Creek	PROJECT NO. 0151-06
WELL DESIGNATION: MW-26N	DATE(S) DRILLED: 6/28/94-6/30/94
DRILLING CONTRACTOR: Walton Corporation	DRILLING METHOD: Mud Rotary
BORING DIAMETER: 14" to 32'; 10" to 168'	SAMPLING METHOD: Drill Cuttings
SAMPLING INTERVAL: Continuous	TOTAL DEPTH: 168'
LOGGED BY: C. W. Geiger	
SCREENED SIZE AND MATERIAL: 4" Schedule 40 PVC, 0.020" slots	SCREENED INTERVAL: 168'-108'
CASING SIZE AND MATERIAL: 4" Schedule 40 PVC	CASED INTERVAL: 108'- +3' above grade
GRAVEL PACK SIZE: #2 Morie Sand	PACKED INTERVAL: 168'-105'
GROUT TYPE: Cement-Bentonite	GROUTED INTERVAL: 101'-0
GROUTING METHOD: Pressure	BENTONITE SEAL: 105'-101'
DEVELOPMENT METHOD: Surging/Air Lifting TIME: 180 minutes	ESTIMATED YIELD: 100 gpm
STATIC WATER DEPTH: DATE: 7/05/94	REFERENCE:
REMARKS:	

SAMPLE INTERVAL (feet)		LITHOLOGIC INTERVAL (feet)		HEADSPACE READING (units)	SPOON BLOWS	RECOVERY	CLASSIFICATION OF MATERIAL
From	To	From	To				
NA	NA	0	9	NA	NA	NA	Brown/gray clay.
NA	NA	9	15	NA	NA	NA	Orange-brown fine to coarse sand; some silt.
NA	NA	15	21	NA	NA	NA	Orange-brown fine to coarse sand.
NA	NA	21	25	NA	NA	NA	Brown-gray silty clay.
NA	NA	25	29	NA	NA	NA	Red, white, brown silty clay with some fine sand.
NA	NA	29	57	NA	NA	NA	Red, white, gray clay.
NA	NA	57	78	NA	NA	NA	Gray, clay with some fine sand, iron ore, wood.
NA	NA	78	94	NA	NA	NA	White and light gray clay.
NA	NA	94	110	NA	NA	NA	Gray clay.
NA	NA	110	126	NA	NA	NA	Fine to medium tan sand.
NA	NA	126	166	NA	NA	NA	Fine to coarse tan sand with white clay seams.
NA	NA	166		NA	NA	NA	White and gray clay.

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TELEPHONE 302/337-8254

Delmarva Drilling Co., Inc.

P. O. BOX 188 • BRIDGEVILLE, DELAWARE 19933

Water Well Contractors

CUSTOMER Roy F. Weston, Inc. #28 JOB 1604

ADDRESS New Castle DATE 3-14-73

LOCATION Gravel Pit

FEET FROM GROUND SURFACE 0 TO.....	WELL LOG
	Test hole
0 - 26	Stones gravel clay sand, pea gravel
26 - 36	Clay
36 - 37	Iron ore layers (left a ledge in hole)
37 - 52	Clay and sand layers
52 - 53	Clay, gray
53 - 76	Sand with clay layers
76 - 88	Red and gray clay with little sand
88 - 90	Fine to coarse sand with little clay layers
90 - 112	Fine to coarse sand
112 - 118	Fine to med sand with gray clay layers
118 - 119	Red and gray clay
119 - 140	Fine to med sand with clay layers
	T. D. 140

GROUND

TOTAL DEPTH - FT.

CASING

SCREEN

WELL NO. [illegible]	DIAMETER OF WELL [illegible]	DEPT. OF WELL [illegible]
HRS. PUMPED [illegible]	SLOT SIZE .016	TYPE OF CASING [illegible]
CAPACITY G.P.M. [illegible]	DRILLING MACHINE NO. [illegible] 2	LENGTH OF CASING [illegible]
STATIC LEVEL [illegible]	DRILLER [illegible]	DISTANCE TO TOP OF SCREEN [illegible]
PUMPING LEVEL	GRAVEL [illegible]	TYPE SCREEN [illegible]
SPECIFIC CAPACITY	BAGS OF CEMENT [illegible]	SIZE OF SCREEN [illegible]
PUMPED WITH	DATE WELL COMPLETED [illegible]	
DEPTH OF CEMENT GROUT	DRILLER'S HELPER [illegible]	
DEPTH GRAVEL PACKED		

WELL DRILLER SIGNATURE

TELEPHONE 302/337-8254

Delmarva Drilling Co., Inc.

P. O. BOX 188 • BRIDGEVILLE, DELAWARE 19933

Water Well Contractors

CUSTOMER Roy F. Weston, Inc. JOB 1604

ADDRESS New Castle, Dela DATE 3-16-73

LOCATION Gravel pit GS-15 # 29

FEET FROM GROUND SURFACE 0 TO.....	WELL LOG
0 - 5	Clay and sand mixed
5 - 9	Blue clay
9 - 19	Fine to coarse sand with gravel
19 - 24	Gray clay
24 - 33	Gray and red clay with sand layers
33 - 65	Fine to coarse tan sand
65 - 72	Fine to coarse tan sand with clay layers
72 - 81	Fine to med. sand with clay layers
81 - 110	Fine to coarse tan sand with white clay layers
110 - 115	White clay with little sand
115 - 128	Brown clay

GROUND

TOTAL DEPTH - FT.

CASING

SCREEN

WELL NO.	DIAMETER OF WELL 6"	DEPT. OF WELL [illegible]
HRS. PUMPED	SLOT SIZE	TYPE OF CASING [illegible]
CAPACITY G.P.M.	DRILLING MACHINE NO. [illegible]	LENGTH OF CASING [illegible]
STATIC LEVEL	DRILLER [illegible]	DISTANCE TO TOP OF SCREEN [illegible]
PUMPING LEVEL	GRAVEL	TYPE SCREEN
SPECIFIC CAPACITY	BAGS OF CEMENT	SIZE OF SCREEN [illegible]
PUMPED WITH	DATE WELL COMPLETED [illegible]	
DEPTH OF CEMENT GROUT [illegible]	DRILLER'S HELPER [illegible]	[illegible]
DEPTH GRAVEL PACKED [illegible]		WELL DRILLER SIGNATURE

Delmarva Drilling Co., Inc.

P. O. BOX 188 • BRIDGEVILLE, DELAWARE 19933

Water Well Contractors

CUSTOMER Roy F. Weston Inc. JOB 1604

ADDRESS New Castle, Dela. DATE 3/23/73

LOCATION Gravel pit #31

GROUND

TOTAL DEPTH • FT.

CASING

SCREEN

FEET FROM GROUND SURFACE 0 TO.....	WELL LOG
0-5	Fill material
5-10	Green and Brown Clay
10-22	Fine to course tan sand with gravel
22-54	White clay, red red clay sand layers fine to med.
54-56	Fine to med. sand with iron ore layers
56-63	Fine to med. sand with clay layers
63-74	Fine to course sand with clay layers
74-81	Fine to course sand
81-93	Fine sand with white clay layers
93-100	Fine to course sand with clay layers
100-110	Fine sand with white clay layers
110-120	Brown clay
	T.D.W. 116'
	Feeder tube 1' above-22'

WELL NO. #31	DIAMETER OF WELL 6"	DEPT. OF WELL 116'
HRS. PUMPED [illegible]	SLOT SIZE .016	TYPE OF CASING steel-P.V.C.
CAPACITY G.P.M. [illegible]	DRILLING MACHINE NO. [illegible]	LENGTH OF CASING 59'
STATIC LEVEL [illegible]	DRILLER Pierson	DISTANCE TO TOP OF SCREEN 59' -1[illegible]
PUMPING LEVEL —	GRAVEL [illegible]	TYPE SCREEN P.V.C.
SPECIFIC CAPACITY —	BAGS OF CEMENT 12	SIZE OF SCREEN 6"
PUMPED WITH [illegible]	DATE WELL COMPLETED 3/27/73	
DEPTH OF CEMENT GROUT [illegible]	DRILLER'S HELPER Wallace	
DEPTH GRAVEL PACKED [illegible]		

Pierson
WELL DRILLER SIGNATURE

TETRA TECH INC. WELL DRILLING LOG	PERMIT NO. SHEET: 1 of 1
PROJECT: Army Creek	PROJECT NO. 0151-14
WELL DESIGNATION: MW-38N	DATE(S) DRILLED: 5/23/94-5/25/94
DRILLING CONTRACTOR: Walton Corporation	DRILLING METHOD: Mud Rotary
BORING DIAMETER: 14" to 47'; 10" to 132'	SAMPLING METHOD: Drill Cuttings
SAMPLING INTERVAL: Continuous	TOTAL DEPTH: 132'
LOGGED BY: C. W. Geiger	
SCREENED SIZE AND MATERIAL: 4" Schedule 40 PVC, 0.020" slots	SCREENED INTERVAL: 132'-72'
CASING SIZE AND MATERIAL: 4" Schedule 40 PVC	CASED INTERVAL: 72'- +3' above grade
GRAVEL PACK SIZE: #2 Morie Sand	PACKED INTERVAL: 132'-69'
GROUT TYPE: Cement-Bentonite	GROUTED INTERVAL: 66'-0
GROUTING METHOD: Pressure	BENTONITE SEAL: 69'-66'
DEVELOPMENT METHOD: Surging/Air Lifting TIME: 180 minutes	ESTIMATED YIELD: 45 gpm
STATIC WATER DEPTH: DATE: 6/08/94	REFERENCE:
REMARKS:	

SAMPLE INTERVAL (feet)		LITHOLOGIC INTERVAL (feet)		HEADSPACE READING (units)	SPOON BLOWS	RECOVERY	CLASSIFICATION OF MATERIAL
From	To	From	To				
NA	NA	0	38	NA	NA	NA	Brown fine to coarse sand with gravel.
NA	NA	38	76	NA	NA	NA	Gray, brown, yellow, white silty clay with iron ore seams.
NA	NA	76	116	NA	NA	NA	Very fine to medium orange-brown sand.
NA	NA	116	126	NA	NA	NA	White medium to coarse sand with gravel.
NA	NA	126	132	NA	NA	NA	Brown fine to coarse sand.
NA	NA	132	133	NA	NA	NA	Iron ore seam.
NA	NA	133	136	NA	NA	NA	White clay.

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TETRA TECH INC. WELL DRILLING LOG	PERMIT NO. SHEET: 1 of 1
PROJECT: Army Creek	PROJECT NO. 0151-06
WELL DESIGNATION: MW-49N	DATE(S) DRILLED: 6/20/94-6/24/94
DRILLING CONTRACTOR: Walton Corporation	DRILLING METHOD: Mud Rotary
BORING DIAMETER: 14" to 57'; 10" to 158'	SAMPLING METHOD: Drill Cuttings
SAMPLING INTERVAL: Continuous	TOTAL DEPTH: 158'
LOGGED BY: C. W. Geiger	
SCREENED SIZE AND MATERIAL: 4" Schedule 40 PVC, 0.020" slots	SCREENED INTERVAL: 158'-113'
CASING SIZE AND MATERIAL: 4" Schedule 40 PVC	CASED INTERVAL: 113'- +3' above grade
GRAVEL PACK SIZE: #2 Morie Sand	PACKED INTERVAL: 158'-109'
GROUT TYPE: Cement-Bentonite	GROUTED INTERVAL: 105'-0
GROUTING METHOD: Pressure	BENTONITE SEAL: 109'-105'
DEVELOPMENT METHOD: Surging/Air Lifting TIME: 180 minutes	ESTIMATED YIELD: 50 gpm
STATIC WATER DEPTH: DATE: 7/06/94	REFERENCE:
REMARKS:	

SAMPLE INTERVAL (feet)		LITHOLOGIC INTERVAL (feet)		HEADSPACE READING (units)	SPOON BLOWS	RECOVERY	CLASSIFICATION OF MATERIAL
From	To	From	To				
NA	NA	0	5	NA	NA	NA	Brown silty clay.
NA	NA	5	53.5	NA	NA	NA	Orange-brown, fine to coarse sand with some silt and gravel.
NA	NA	53.5	75	NA	NA	NA	Red, white, gray clay.
NA	NA	75	88	NA	NA	NA	White clay.
NA	NA	88	98	NA	NA	NA	Gray clay with small iron ore seams.
NA	NA	98	114	NA	NA	NA	Red, white, yellow clay interbedded with seams of fine tan sand and iron ore.
NA	NA	114	125	NA	NA	NA	Tan fine to medium sand with some lenses of clay and iron ore. lenses.
NA	NA	125	139	NA	NA	NA	Orange brown fine to coarse sand with gravel.
NA	NA	139	158	NA	NA	NA	White medium to coarse sand with gravel.
NA	NA	158		NA	NA	NA	White, red clay.

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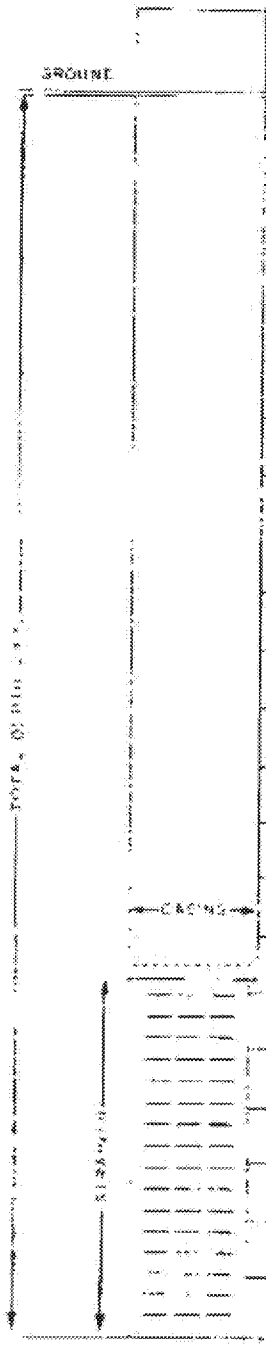
ACL 56-70
PARAC well logs

A.C. SCHULTES & SONS, INC.

SINGLE CASE WELL

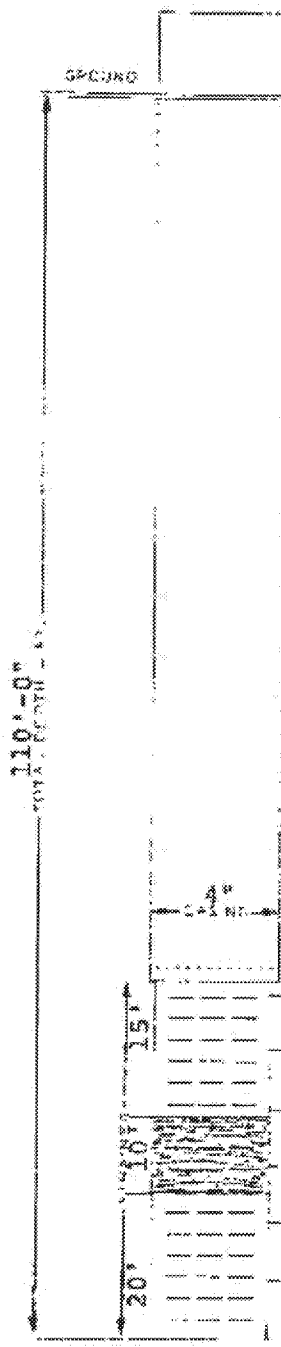


WELL LOG	FEET FROM GROUND SURFACE	NAME OF OWNER
Brown sand	0 to 9	New Castle County
Yellow Clay	9' - 11'	Job # 18390
Sand stone	11' - 13'	Location Langollin Landfill
Silty, orange clay	13' - 17'	No. Monitor 56
Brown sand	17' - 18'	Hrs. Pumped BIFW 12 hou
Red & white clay	18' - 33'	Capacity G.P.M. 60
Fine, silty sand	33' - 50'	Static Level 29'-6"
Fine, white sand	50' - 58'	Pumping Level
Layers of white clay		Specific Capacity
White clay	58' - 70'	Diameter of Well 4"
White sand/ layers of	70' - 101'	Depth of Well (ground) 100'
clay		Length of Casing 75'
Red clay	101' - 105'	Distance to Top of Packer
		Type Screen PVC
		Size of Screen 4"
		Length of Screen 25'
		Top Screen Fitting couple
		Bottom Screen Fitting cap
		Blank NO
		Slot Size .020
		Drilling Machine No. D-3
		Driller Charlie Kramer
		Grout #2
		Bags of Cement 15
		Date Well Completed 7-9-80

Remarks: Table approx. 3' above ground level

A.C. SCHULTES & SONS, INC.

SINGLE CASE WELL



WELL LOG	FEET FROM GROUND SURFACE	NAME OF OWNER
Brown clay	0 TO 4	New Castle County
Brown sand	4 - 6	Job # 18390
Gray clay	6 - 15	Location Landfill
Brown sand	15 - 19	Well No. Monitor #58
Sand stone	19-23	Hrs. Pumped
White clay	23 - 29	Capacity G.P.M. 60
Brown sand/ layers clay	29 - 45	Static Level
Red & White clay	45 - 63	Pumping Level
Sand, silty/layers clay	63 - 76	Specific Capacity
White sand	76 - 81	Diameter of Well 4"
Hard clay	81 - 89	Depth of Well - ground 110'-0"
Fine sand & mud	89 - 106	Length of Casing 65'-0"
White clay	106 - 108	Distance to Top of Packer
White sand	108 - 111	Type Screen PVC
Red clay	111 - 118	Size of Screen 4"
		Length of Screen 35'-0"
		Top Screen Fitting Couple
		Bottom Screen Fitting Cap
		Blank Yes - 10'-0"
		Slot Size .020"
		Drilling Machine No. D3
		Driller Kramer
		Gravel #2
		Bags of Cement 15
		Date No. Completed 7-8-80

Notes: Yes = above; "Unknown ground level"

TETRA TECH INC. - TEST BORING LOG Page 1 of 2

Project Name:	Army Creek	Project No.:	R0151-20
Project Location:	New Castle De		
Test Boring No.:	P-4	Date(s) Drilled: 12/111/02 to	Inspector: D. Neidigh
Drilling Contractor: A. C. Schultes		Drilling Method: MudRotary/Split Spoon	Driller: Dennis G
Surface Elevation (ft):		Groundwater Depth (ft):	Total Depth (ft):

Sample		Sample Depth (ft)		Recovery (inches)	PID readings		Strata Depth (ft)				Blow Counts			
Time	No.	From	To		Depth (ft)	PPM	From	To	Description of Materials	Moisture	0-6"	6-12"	12-18"	18-24"
							0	56	Orange brown sand with trace gravel. Gravel layer @ 24'					
									and 42' to 45'					
							56	70	Red & gray clay with tracefine sand					
1040	1	70	72	4					Dark gray clay withsome very fine sand	M				
1115	2	75	77	3					Same as above		130/4			
1153	3	80	82	2					Dark redesh brown sand, silt, clay		100	50/3		
124	4	85	87	6					brown & gray sand trace fine gravel, little silt		132/2 *			
1300	5	90	92	3					brown sand, little silt, trace fine gravel		150/3 *			
1400	6	95	97	1					Light brown fine to medium sand little silt		150/3 *			
1440	7	100	102	1					Same as above		150/2 *			
1540	8	105	107	1					Brown sand		172/4 *			
1630	9	110	112	6					brown fine to coarse sand, little silt		154			
											70	100	100+	
940	10	115	117	8					light brown fine sand, trace silt					

Notes and comments

* At these locations the hammer was raised to the top of the mast and dropped 3 to 4 times to remove the accumlated sand and gravel that had fallen from the side walls of the borehole prior to driving the spoon for lithologic samples.

Moisture codes: D-dry, M-moist, W-wet, S-saturated

TETRA TECH INC. - TEST BORING LOG Page 2 of 2

Project Name:	Army Creek		Project No.: R0151-20
Project Location:	New Castle De		
Test Boring No.:	P-4	Date(s) Drilled: 12/111/02 to	Inspector: D. Neidigh
Drilling Contractor: A. C. Schultes		Drilling Method: MudRotary/Split Spoon	Driller: Dennis G
Surface Elevation (ft):		Groundwater Depth (ft):	Total Depth (ft):

Sample		Sample Depth (ft)		Recovery (inches)	PID readings		Strata Depth (ft)		Description of Materials	Moisture	Blow Counts			
Time	No.	From	To		Depth (ft)	PPM	From	To			0-6"	6-12"	12-18"	18-24"
1053	11	120	122	4					light brown fine sand, trace silt		71	131	156	300*
1227	12	125	127	3					Brown fine sand and clay		17	17	100	200*
1357	13	130	132	1					White clay with little very fine sand		100	140/4 *		
1455	14	135	137	1					Same as above		100	150/3 *		

Notes and comments

Gig chatter and slow drilling 78' to 80'.

1015 taking water @ 100' to 105'

Moisture codes: D-dry, M-moist, W-wet, S-saturated

TETRA TECH INC. - TEST BORING LOG

Project Name:	Army Creek		Project No.: R0151-20
Project Location:	New Castle De		
Test Boring No.:	P-5L	Date(s) Drilled: 11/27/02 to 11/30/02	Inspector: D. Neidigh
Drilling Contractor: A. C. Schultes		Drilling Method: Rotary/Split Spoon	Driller: Dennis G
Surface Elevation (ft):		Groundwater Depth (ft):	Total Depth (ft):

Sample		Sample Depth (ft)		Recovery (inches)	PID readings		Strata Depth (ft)				Blow Counts			
Time	No.	From	To		Depth (ft)	PPM	From	To	Description of Materials	Moisture	0-6"	6-12"	12-18"	18-24"
		0	12						Fine to medium sand and gravel					
		12	19						Sand & white clay					
		19	40						Fine to medium sand and gravel					
		40	70						Interbedded clay & sand					
		70	80						Medium sand					
		80	100						White & Red clay					
		100	115						Interbedded sand &clay					
		115	136						Fine to medium sand					
		136	180						yellow, red & gray glay					

Notes and comments

Moisture codes: D-dry, M-moist, W-wet, S-saturated

TETRA TECH INC. - TEST BORING LOG Page 1 of 2

Project Name:	Army Creek		Project No.: R0151-10
Project Location:	New Castle De		
Test Boring No.:	P-5U	Date(s) Drilled: 12/12/01 & 12/13/02	Inspector: E Scott
Drilling Contractor: A. C. Schultes		Drilling Method: Mud Rotary/Split Spoon	Driller: Dennis G
Surface Elevation (ft):		Groundwater Depth (ft):	Total Depth (ft):

Sample		Sample Depth (ft)		Recovery (inches)	PID readings		Strata Depth (ft)				Blow Counts			
Time	No.	From	To		Depth (ft)	PPM	From	To	Description of Materials	Moisture	0-6"	6-12"	12-18"	18-24"
1020		50	53	N/A					Very rocky, minor red, yellow clay, gravel 1/4" to 2" consisting of quartz,					
									smoky quartz, gray sandstone sub-angular to sub-rounded. From cuttings					
1050		55		N/A					White clay. From cuttings					
1115		60	62	4		0	0	4	Very fine, very dense beige sand	M	90			
1130		65	67	4		0	0	4	Very fine, very dense beige sand	M	115			
1150		70	72	6		0	0	6	Very fine, dense sand with minor white & red clay mixed in	M	176			
1243	1	75	77	12		0	0	12	Very fine, dense sand with minor white & red clay mixed interfingers	M	900			
1320		80	82	2		0	0	2	White clay into hard red clay	M	95			
1345		85	87	12		0	0	12	Red and white clay to white-gray clay, very dense and very hard	M	102			
1410		90	92	8		0	0	8	Red & white clay to white sandy clay white sand layer 4" thick to white clay	M	92			
1430		95	97	4		0	0	4	Red and white clay; last 2" fine orange sand					

Notes and comments

Moisture codes: D-dry, M-moist, W-wet, S-saturated

TETRA TECH INC. - TEST BORING LOG

Project Name:	Army Creek		Project No.: R0151-10
Project Location:	New Castle De		
Test Boring No.:	P-5U	Date(s) Drilled: 12/12/01 & 12/13/02	Inspector: E Scott
Drilling Contractor:	A. C. Schultes	Drilling Method: Mud Rotary/Split Spoon	Driller: Dennis G
Surface Elevation (ft):		Groundwater Depth (ft):	Total Depth (ft):

Sample		Sample Depth (ft)		Recovery (inches)	PID readings		Strata Depth (ft)				Blow Counts			
Time	No.	From	To		Depth (ft)	PPM	From	To	Description of Materials	Moisture	0-6"	6-12"	12-18"	18-24"
1500		100	102	6		0	0	6	Medium gray/white sand, minor quartz pieces	M	114			
1536		105	107	6		0	0	6	Gray/white fine sand	M	100			
1610		110	112	3		0	0	3	White silt	M	100			
1215		115	117	6		0	0	6	Dense fine white sand	W	115			
1250		120	122	2		0	0	2	Red & white clay	W	83			
1310	2	130	132	12		0	0	12	Dense fine beige sand	W	80			

TETRA TECH INC. - TEST BORING LOG

Project Name: Army Creek			Project No.: R0151-20
Project Location: New Castle De			
Test Boring No.: P8	Date(s) Drilled: 2/4/02	Inspector: E Scott	
Drilling Contractor: A. C. Schultes	Drilling Method: Rotary/Split Spoon.	Driller: Dennis G	
Surface Elevation (ft):	Groundwater Depth (ft):	Total Depth (ft): 117	

Sample		Sample Depth (ft)		Recovery (inches)	PID readings		Strata Depth (ft)		Description of Materials	Moisture	Blow Counts			
Time	No.	From	To		Depth (ft)	PPM	From	To			0-6"	6-12"	12-18"	18-24"
1108	1	60	62	8		0			Red and gray very hard dense clay					
1115	2	65	67	12		0			Gray clay, very dense					
1148	3	70	72	12		0			Gray clay, soft ~2" to a dark gray clay, very hard, very dense					
1202	4	75	77	12		0			Gray clay, soft ~8" to a dark gray clay, very hard, very dense					
1210	5	80	82	12		0			Very dark hard dense gray clay					
1230	6	85	87	12		0			Dark gray clay. Had dense. Last 2" soft and broken by small wood pieces					
1242	7	90	92	8		0			Dark gray clay very dense					
1300	8	95	97	6		0			Fine tan sand	M				
1315	9	100	102	1		0			Fine tan sand	M				
1340	10	105	107	6		0			Medium sand, tan, heavy iron staining					
1410	11	110	112	6		0			Alternating gray clay and orange iron-stianed sand lenses					
1435	12	115	117	8		0			Gray clay, soft					

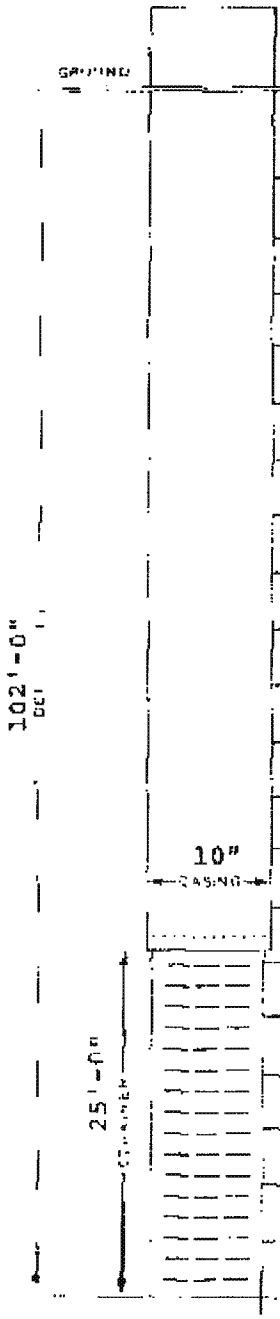
Notes and comments

Moisture codes: D-dry, M-moist, W-wet, S-saturated

ACL RW-10 to RW-14 Well Logs

A.C. SCHULTES & SONS, INC.

SINGLE CASE WELL



WELL LOG	FEET FROM GROUND SURFACE	NAME OF OWNER
Brown sand	0 TO 9	New Castle County
Sand Stone	9' - 10'	Job # 18390
Red & white clay	10' - 21'	Location Langollen Landfill
White & tan clay	21' - 29'	Well No. RW # 10
Gray clay	29' - 33'	Hrs. Pumped 8
Sand white	33' - 60'	Capacity G.P.M. 508
Sand & gravel	60' - 79'	Static Level 31'-0"
Sand, layers of gravel	79' - 1-3'	Pumping Level 53'-0"
Hard, red clay	103' - 107'	Specific Capacity 25
White clay	107' - 112'	Diameter of Well 10"
Red clay	112' - 102.5'	Depth of Well (ground) 102'-0"
		Length of Casing 78'-0"
		Distance to Top of Packer (gr.)
		Type Screen P.V.C
		Size of Screen 10"
		Length of Screen 25'-0"
		Top Screen Fitting Couple
		Bottom Screen Fitting Cap
		Blank No
		Slot Size .030
		Drilling Machine No. D-3
		Driller Kramer
		Gravel #2
		Bags of Cement 100
		Date Well Completed 6-3-80

Rotary Table approx. 3' above ground level

ATTACHMENT 4

SAMPLING AND ANALYSIS PLAN - REVISION 1

ATTACHMENT 4

SAMPLING AND ANALYSIS PLAN

Army Creek Landfill Superfund Site
New Castle, Delaware

Submitted To: USEPA, Region III
1650 Arch Street
Philadelphia, PA 19103-2029

Submitted By: Army Creek Landfill Trust
100 East Market Street, Suite 1
Newport, DE 19804

Prepared By: Golder Associates Inc.
200 Century Parkway, Suite C
Mt. Laurel, NJ 08054 USA

March 2019
Revision 1

Project No.: 189-9295

A world of capabilities delivered locally

Golder Associates

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1.0 INTRODUCTION AND PROJECT INVOLVEMENT

This Sampling and Analysis Plan, Revision 1 (SAP-Rev 1) was prepared for the Army Creek Landfill (ACL) Superfund Site (Site) in New Castle, Delaware (Site; as shown in Figure 1) for use with the Revised Additional Investigation Work Plan (referred to herein as "Work Plan") dated March 2019 (Ruth Associates Inc. [RAI], 2019). A description of the comments and responses associated with the original Work Plan (February 2018; RAI, 2018) and the original SAP (February 2018; Golder, 2018) are provided in Section 1 of the Work Plan.

This SAP includes the following proposed activities and quality assurance (QA) protocols:

- Soil boring advancement via roto-sonic techniques and installation of monitoring wells in the Upper Potomac Aquifer (UPA)
- Monitoring well development, purging and sampling techniques and associated QA protocols for groundwater
- Monitoring program for the groundwater assessment associated with the western lobe of the ACL and per- and polyfluoroalkyl substances (PFAS) assessment associated with the Site

The following sections of this SAP present the requirements necessary to implement data collection activities in accordance with United States Environmental Protection Agency (USEPA) Requirements for Quality Assurance Project Plans (QAPP) EPA QA/R-5 (March 2001). More specifically:

- Section 2 - Project Background and Administrative Information
- Section 3 - Quality Objectives and Criteria
- Section 4 - Data Generation and Acquisition
- Section 5 - Assessment and Oversight
- Section 6 - Data Validation and Usability

2.0 PROJECT BACKGROUND AND ADMINISTRATIVE INFORMATION

This SAP was prepared in support of the Work Plan; therefore, a brief project background including a description of the additional assessment requested by the USEPA and a summary of the proposed scope of work for the assessment is provided in this section. For additional details, refer to the Work Plan. This section also provides information regarding project organization, training, documents and records that are necessary for the execution of this SAP.

2.1 Problem Definition/Background

In the USEPA's letter dated September 28, 2017, the USEPA requested that the Army Creek Private Settlors (ACPS) and New Castle County (NCC) perform additional Site characterization field work "to determine: 1) the extent of the dissolved metals and 1,2-DCA [1,2,-dichloroethane] contamination in groundwater within the Upper Potomac Aquifer downgradient of the western lobe of the Army Creek Landfill: 2) whether the Army Creek Landfill is a source of PFAS in groundwater within the Upper Potomac Aquifer; and 3) the vulnerability of the Llangollen well field to contaminant releases from the western lobe of the Army Creek Landfill." Based on this request and subsequent discussions and correspondence as documented in the Work Plan, the ACPS and NCC prepared the Work Plan to evaluate the need for additional remedial actions at the Site associated with impacted groundwater observed downgradient of the Site. Figure 2 shows the existing monitoring well locations. The groundwater at and downgradient of the Site is impacted with inorganics (predominantly iron, manganese and cobalt) and volatile organic compounds (VOCs) (primarily 1,2-dichloroethane [1,2-DCA]). Regionally, the groundwater is impacted with PFAS, predominantly perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS), by various facilities in the area. The potential migration pathways are presented as part of the Conceptual Site Model (CSM) in the Work Plan.

2.2 Project/Task Description

The primary objective of this SAP is to present monitoring, assessment and data analysis procedures designed to implement the data collection programs. The resulting data will be used to address data gaps associated with groundwater impacts at the Site. The Data Quality Objectives (DQOs) for the additional investigation activities described in the Work Plan are summarized in Table 1, and the Decision Thresholds/Action Levels are presented in Table 2. The DQO process as it relates to the Measurement Performance Criteria is described in Section 3.

To meet these objectives, ACPS and NCC will install additional monitoring wells downgradient of the western lobe of ACL and collect groundwater samples from new and existing wells to provide additional Site information. The sampling locations and parameters are listed on Table 3, the monitoring point construction information is provided on Table 4, and the locations are shown on Figures 2 and 3.

2.3 Project Organization

The lead regulatory agency for the Site is the USEPA with involvement of the State of Delaware Department of Natural Resources and Environmental Control (DNREC). The following summarizes the organizations involved in this project and distribution for documents:

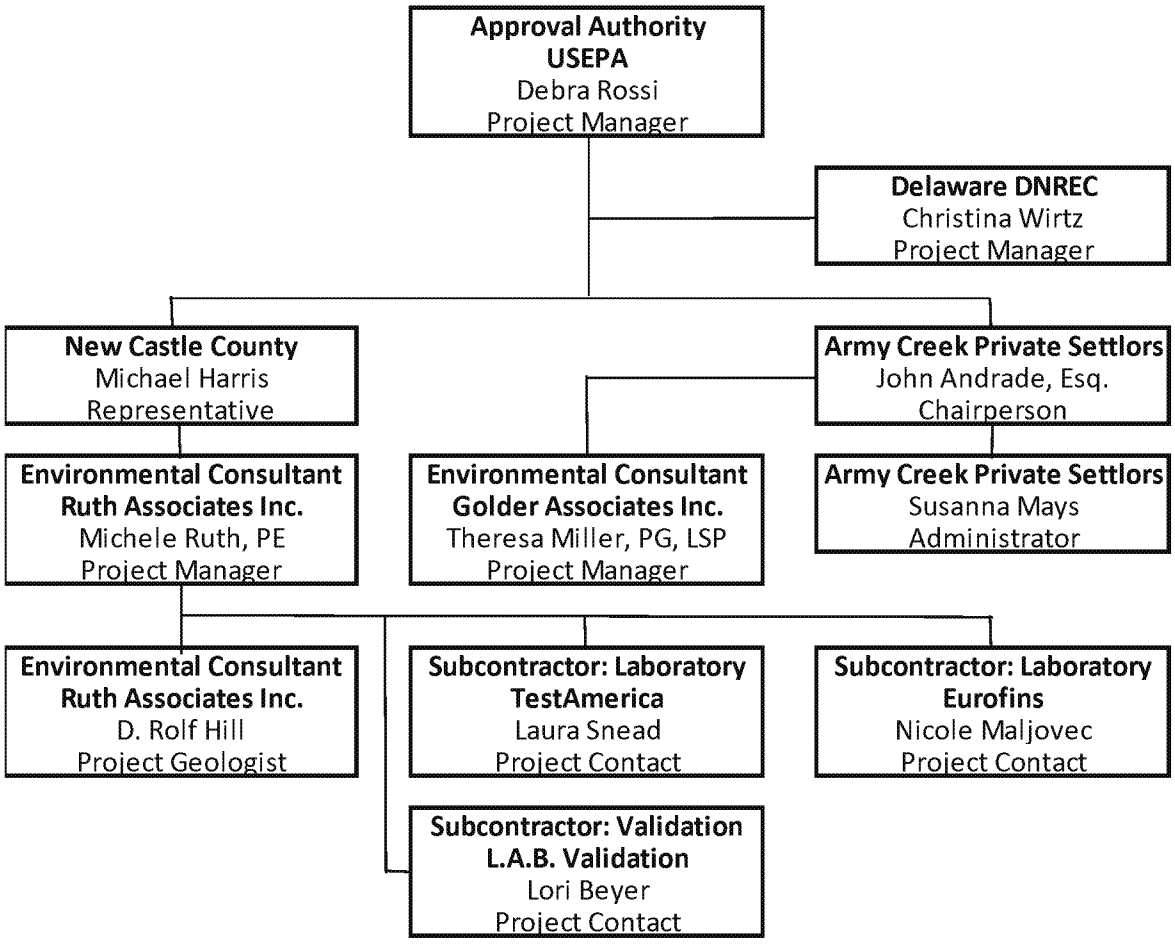
SAP Recipients	Organization
Debra Rossi	USEPA Region III Project Manager
Christina Wirtz	Delaware DNREC Project Manager
John Andrade, Esq.	Chairperson, Army Creek Private Settlors (ACPS)
Susanna Mays	Administrator, ACPS
Mike Harris	New Castle County (NCC)
Michele Ruth	Ruth Associates Inc. (RAI) Project Manager
Theresa Miller	Golder Associates Inc. (Golder) Project Manager

The Project Team Organization Chart is shown below. It should be noted that these individuals have primary responsibility for the project, although other individuals may be involved. The environmental consultant (EC) and field services contractor will be RAI of Stuart, Florida and Golder of Mount Laurel, New Jersey. The chain-of-communication shown below will be followed throughout the project.

Specifically, the above-listed project personnel roles are as follows:

- USEPA Project Manager and USEPA Project Coordinator – Debra Rossi, responsible for regulatory reviews, Agency approvals and coordination between NCC, ACPS and the USEPA
- Delaware DNREC Project Manager – Christina Wirtz, responsible for regulatory reviews, Agency approvals and coordination between NCC, ACPS and DNREC
- ACPS Chairperson – John Andrade, represents the ACPS and responsible for project decisions and coordination between the USEPA, Golder and ACPS, as necessary
- NCC Representative – Mike Harris, represents the Special Services Department of New Castle County Administration and responsible for project decisions and coordination between the USEPA, RAI and NCC, as necessary
- RAI Project Manager – Michele Ruth, primary point-of-contact between NCC, RAI and Golder, responsible for technical direction, overall coordination and management on behalf of NCC
- Golder Project Manager - Theresa Miller, primary point-of-contact between ACPS, RAI and Golder, responsible for technical direction, overall coordination and management on behalf of the ACPS

Analytical chemistry services are anticipated to be provided by TestAmerica of Edison, New Jersey (TestAmerica Edison) and Eurofins Lancaster Laboratories, Inc. (Eurofins) of Lancaster, Pennsylvania. If use of a different laboratory is required to satisfy project needs, the laboratory quality manual and the laboratory standard operating procedures will be forwarded to the USEPA for review prior to use of the laboratory. The data will be validated by a third party – L.A.B. Validation of East Northport, New York.



2.4 Special Training/Certification

The ECs' project team members with appropriate experience, technical skills and training will be selected to perform the project tasks. The subcontractors selected for laboratory analysis were selected based on qualifications and experience of the subcontractor to perform the required work. The subcontractors will meet the general requirements of the USEPA Region III to perform these tasks. The ECs' project personnel responsible for data collection and data quality reviews will be trained in relevant procedures and analytical methodologies.

2.5 Documents and Records

The organizations and their personnel listed in the SAP Distribution List and the ECs will receive the most current, approved version of this SAP. This SAP includes the revision number and date and will be updated as needed based on changes in Site conditions and/or applicable regulatory requirements. The revised SAP will be distributed to the USEPA, DNREC, NCC and the ACPS. The QAPP will include revisions/updated (if applicable) every 3 to 5 years.

The ECs will maintain electronic copies of all laboratory deliverables as part of the project file. A copy of these electronic deliverables will be incorporated into the Site chemical database. No printed reports of the laboratory data will be maintained, because multiple copies of the portable document format (PDF) report version will be maintained and backed up (by ECs as well as each subcontracted laboratory). The ECs will retain chain-of-custody (COC) forms, field documentation forms, including sample field information forms and field notebooks. The ECs will file and maintain data and other records (including interim progress reports) in an accessible location on its premises or in an off-site secured file storage facility for a period of at least 5 years.

For laboratory analytical data, PDF deliverables will be produced from the laboratory in a standard reduced deliverable format and the electronic data deliverables (EDD) will be provided to the USEPA and DNREC in the EQuIS 4-file and Microsoft Excel database format.

The laboratory report format for all analytical data analyses performed by the selected laboratory will consist of the items listed below.

Case Narrative:

- Date of issuance
- Laboratory analysis performed
- Work order batch number
- Numbers of samples and respective matrices
- Quality control (QC) procedures utilized and also references to the acceptance criteria
- Laboratory report contents
- Project name and number
- Condition of samples 'as-received'
- Discussion of whether or not sample holding times were met
- Any deviations from intended analytical strategy
- Any deviations or modifications of the laboratory standard operating procedures (SOPs)
- Discussion of technical problems or other observations which may have created analytical difficulties
- Discussion of any laboratory QC checks which failed to meet project criteria and the corrective actions pursued
- Signature of the Laboratory QA Officer or designee

Chemistry Data Package:

- COC documentation
- Case narrative for each analyzed batch of samples
- Summary page indicating dates of analyses for samples and laboratory QC checks

- Cross referencing of laboratory sample to project sample identification numbers
- Description of data qualifiers to be used
- Sample preparation and analyses for samples
- Sample results (results between the method detection limit (MDL) and quantitation limit (QL) will be reported as estimated values)
- QC summary package including the results of laboratory control samples (LCSs), matrix spike/matrix spike duplicates (MS/MSDs), interference check samples, serial dilutions, laboratory duplicates, and method blanks
- Electronic data deliverable containing the results for field and QC samples. The PFAS data will be provided to the USEPA and DNREC in the EQuIS EDD format.

3.0 QUALITY OBJECTIVES AND CRITERIA

This section describes the approach to the Measurement Performance Criteria which uses data quality indicators expressed as precision, accuracy, representativeness, comparability, completeness, and sensitivity (PARCCS). Where possible, acceptance criteria are specified to help delineate minimum acceptability levels for use of data in the overall decision-making process.

3.1 Precision

Precision refers to the degree to which repeated measurements are similar to one another. It measures the agreement (reproducibility) among individual measurements, obtained under prescribed similar conditions. Measurements that are precise are in close agreement with one another.

Field precision is assessed through the collection and measurement of field duplicates. A field duplicate sample is defined as two or more representative portions taken from the same sampling location, homogenized, split and submitted for identical analyses.

Precision in the laboratory is assessed through the calculation of relative percent differences (RPDs) between sample results. The RPD is calculated according to the following formula.

$$RPD = \frac{2 \times |\text{Amount in Sample 1} - \text{Amount in Sample 2}|}{(\text{Amount in Sample 1} + \text{Amount in Sample 2})} \times 100$$

Precision control limits for all analyses are provided in the Measurement Performance Criteria, Tables 5 through 8. The precision control limits provided are based on the laboratory QC limits, which are routinely re-evaluated following the procedures in the laboratory quality assurance policies and the requirements of the analytical methods. Should the laboratory QC limits change between the submission of this SAP and the sample analyses, the limits in place at the time of sample analysis will be used to evaluate the data and will be reported with the data usability summary.

3.2 Accuracy

Accuracy is the degree of agreement between an observed value and an accepted reference or true value. The accuracy measurement is generally determined by the percent recovery (%R) of a known value. Accuracy as %R is determined by the following equation:

$$\%R = \frac{(\text{Amount in Spiked Sample} - \text{Amount in Sample})}{\text{Known Amount Added}} \times 100$$

Accuracy in the field is assessed through the use of equipment rinsate and trip blanks to assess the potential of cross contamination. In addition, field accuracy is assessed by the adherence to all sample handling, preservation, and holding time criteria.

Laboratory accuracy and bias will be assessed through the analysis of standard reference materials (SRMs), LCSs, MS/MSDs, surrogate compounds, and the determination of the %R for these measurements. General accuracy control limits are provided in the Measurement Performance Tables, Tables 5 through 8. Where accuracy criteria are not met, data will be qualified as either estimated (minor deviation from accuracy criteria) or rejected (major deviation from accuracy criteria). Data qualified as rejected should not be used for decision making purposes.

3.3 Representativeness

Representativeness expresses the degree to which data accurately and precisely represents a characteristic of a population, a parameter variation at a sampling point, a process condition, or an environmental condition within a defined spatial and/or temporal boundary.

Representativeness is dependent upon the proper design of the sampling program and will be satisfied by ensuring that the Work Plan is followed and that proper sampling techniques are used. The sampling program was designed to provide data representative of Site conditions. During development of this program, consideration was given to historical activities, existing analytical data, physical setting and processes. Using the proper analytical procedures, appropriate methods, meeting sample holding times and meeting QC criteria for each parameter affirms representativeness in the laboratory. An additional assessment of representativeness will be made through field duplicates. While field duplicates are primarily used to assess precision, they also indicate sample homogeneity and therefore the representativeness of the data to the Site.

3.4 Comparability

Comparability is an expression of the confidence with which one data set can be compared to another. Comparability of data is achieved by ensuring Site-wide sample collection and analyses follow the same protocol. Comparability depends upon the proper design of the sampling program and will be satisfied by following the Work Plan, SOPs, and using the proper sampling techniques. The field manager will routinely oversee field activities and verify compliance with field sampling procedures identified in the Work Plan.

Analytical data are comparable when similar analytical methods are used. Appropriate laboratory personnel will review and have a working knowledge of the laboratory SOPs to be used during the analysis of samples for the investigation. Additionally, the laboratory QA Manager will review data generated, determine compliance with method requirements, and attest that QA objectives are met.

3.5 Completeness

Completeness is a measure of the amount of valid data obtained from a measurement system compared to the amount of data that was expected under normal conditions. Data are considered valid and complete

if QC elements have met the criteria established in this SAP. Qualified data may be considered usable and will be considered complete on a case by case basis.

Following completion of the analytical testing, the percent completeness will be calculated by the following equation:

$$\textit{Completeness} = \frac{\textit{(number of valid measurements)}}{\textit{(number of measurements planned)}} \times 100$$

The laboratory and field completeness goal for this project is greater than 85 percent. Field measurements not collected from a specified location, or samples not collected due to environmental conditions, will be identified in the report. Data qualified by the laboratory or data reviewer as estimated is usable and therefore considered complete; however, data qualified as rejected are not usable and do not count toward completeness goals.

3.6 Sensitivity

Sensitivity is defined as the capability of a method or instrument to discriminate between measurement responses representing different levels of a variable of interest. Two measurement responses of interest in assessing sensitivity are the MDL and the QL. The MDL is defined as the minimum concentration of a substance that can be identified, measured and reported with a 99 percent confidence that the substance concentration is greater than zero, for a specific matrix containing the substance. The MDLs are determined as outlined in 40 CFR Part 136. The QL is defined as the level of measurement that can be reliably achieved within specified limits of precision and accuracy during routine laboratory operations. The QLs are generally 2 to 5 times greater than the MDLs.

The sensitivity for field measurements will be determined, in part, by the limitations of field instrumentation as described in the manufacturer's manual and specific field measurement SOPs. Other factors that will influence sensitivity include matrix and environmental conditions.

The MDL and QL requirements for this project are identified in Table 9. The laboratory will verify analytical QLs defined by a point on the calibration curve which is below the stated QL. Additionally, the laboratory will provide MDL studies for each compound upon request by the USEPA and/or EC's QA officer. Should the laboratory MDL or QL change between the submission of this SAP and the sample analyses, the limits in place at the time of sample analysis will be used to evaluate the data and reported with the data usability summary.

4.0 DATA GENERATION AND ACQUISITION

This section provides the details regarding the field sampling program including: drilling/soil boring advancement, monitoring well installation and development, groundwater sampling and analysis, equipment calibration and decontamination, handling of investigation-derived waste (IDW), and data management. The DQOs (see Table 1) and the Decision Thresholds/Action Levels (see Table 2) for the additional investigation activities were used in development of these methods. Changes and/or additions to the activities and/or processes in this SAP may be necessary due to changed conditions in the field. The USEPA will be informed of these changes and approvals will be sought where necessary.

4.1 Sampling Process Design

The monitoring program includes collection of groundwater samples for analysis of various parameters. The sample locations are being reviewed as part of the Work Plan submitted to the USEPA with this SAP. These data will be used to address data gaps and evaluate the need for remedial actions at the Site. All work will be conducted following Health and Safety Protocols and a Health and Safety Plan (HASP) will be developed by the ECs.

4.2 Locations, Frequencies and Matrices

This section summarizes the sampling locations, frequencies and matrices detailed in the Work Plan for the assessment downgradient of ACL's western lobe and the assessment of PFAS in water within the ACL and UPA groundwater (see Conceptual Stratigraphic Column included as Figure 4) in the vicinity of the Site.

4.2.1 Western Lobe

The proposed sampling locations to address the UPA groundwater data gaps include six wells to be installed into the UPA downgradient of ACL's western lobe and sampling of three existing wells. The proposed locations of the new wells (P-4L, MW-22NU, WL-1U, WL-1L, WL-2U and WL-2L) and existing wells included in the sampling program are shown on Figure 2 and are listed on Table 3. After installation and development of the new wells, groundwater from the nine wells will be sampled quarterly, as outlined in this SAP, for total and dissolved iron, manganese, cobalt and VOCs (including 1,2-DCA). Major anions and cations will be monitored semi-annually coincident with the semi-annual monitoring events for the Site. The metals and VOCs results will be compared to primary and secondary drinking water standards (maximum contaminant levels, MCLs) and regional screening levels (RSLs).

Due to the long screen intervals (wells screened across both the upper sand and the lower sand of the UPA) of several wells, wells P-4 and MW-22N will be purged and sampled using both low-flow and volume averaging techniques. Table 3 lists the locations, frequency and parameters for these wells and Table 4 indicates the wells included as part of the comparative analysis. Section 4.3.2.1 describes the water level

monitoring procedure and schedule for the wells listed in Table 3. Section 4.3.3.2 describes the low-flow purging and sampling methodology and Section 4.3.3.3 describes the volume-average purging for the wells listed on Table 4.

4.2.2 PFAS in Groundwater

The proposed program to assess the PFAS in groundwater includes sampling and analysis of groundwater samples from 19 monitoring wells, including the six wells to be installed into the UPA downgradient of ACL's western lobe, and up to 10 gas vents within the ACL. Due to the long screen intervals (wells screened across both the upper sand and the lower sand of the UPA) of several wells included in the PFAS monitoring program, wells MW-28, MW-29, MW-31, BW-3, and MW-58 will be purged and sampled from two locations within the screened interval to assess potential differences in concentrations across the two units (see discussion in Section 4.3.3.3).

Due to the limited water generally available within the gas vents and difficulties associated with purging and collecting water samples from the gas vents within the ACL[1], it may not be possible to collect samples from 10 gas vents. It is anticipated that the gas vent samples will be collected following the volume averaging technique using bailers (or similar method) described in Section 4.3.3.2. Section 4.3.3.1 describes the low-flow purging and sampling methodology for the newly installed wells and existing UPA wells.

The proposed locations in the sampling program are shown on Figure 3 and are listed on Table 4. These wells and gas vents will be sampled for PFAS one time, and the sampling event will be contemporaneous with the annual PFAS sampling event for the adjacent Delaware Sand & Gravel Superfund Site.

4.3 Sampling and Data Collection Methods

4.3.1 Drilling

4.3.1.1 Pre-Drilling Activities

Soil borings will be advanced using Rotosonic drilling methods. Rotosonic drilling is a dual-cased system that employs high frequency vibration to obtain continuous core samples of unconsolidated formations and many consolidated formations (including bedrock), and/or to advance casing for well construction and other purposes. Rotosonic rigs have been used successfully in the area of the Site. A driller licensed by the State of Delaware will be utilized for the work. The Delaware-licensed driller will obtain drilling permits for the monitoring wells. Prior to any ground disturbance at the proposed drilling locations, the following activities will be performed to avoid subsurface utilities:

[1] The landfill gas vents were not installed for the purpose of monitoring leachate within the landfill or collecting aqueous samples. Aspects of their construction could affect data quality. Previous monitoring of leachate in the gas vents indicates that the liquids which enter then screened interval of the gas vents will be thicker than water and must be removed via bailer rather than pumped to the surface.

1) The drilling locations will be pre-marked out and Miss Utility will be contacted to mark out utilities on public properties;

2) Available Site drawings and public utility information will be reviewed to locate utilities on private properties; and

3) Private utility locating service will be contracted to perform ground-penetrating radar (GPR) and/or electromagnetic (EM) surveys

PFAS-compliant materials (as certified by the manufacturer), including drilling fluids and tooling lubricants, will be used during drilling activities. If information related to PFAS compliance of a material is not available, the driller may be asked to change materials used, if possible, or a material sample or rinse sample of equipment (if applicable) will be collected for analysis of PFAS.

4.3.1.2 Boring Advancement

The anticipated drilling sequence is as follows:

- Core barrel advancement (using limited fluids, air, or muds)
- Casing override (potable water minimally used between outer and inner casing)
- Core barrel and geologic sample retrieval
- Repeat core advancement

The proposed borings (see Table 3 and Figure 2) will be advanced using Rotosonic drilling techniques which will allow for a collection of continuous soil core. It is recommended that the first boring installed in the location of a proposed UPA upper and lower sand well pair be advanced to the top of the Middle Potomac Confining Unit (MPCU; see Figure 4) and be completed with a UPA lower sand well. To avoid the potential for communication between the UPA upper sand and UPA lower sand wells within a pair, the separate borings will be advanced such that the wells will be installed in borings that are separated from each other by between 15 and 25 feet horizontally.

For each proposed boring identified in Section 4.3.2, an 8-inch to 12-inch diameter (dependent on anticipated screened lithologic unit), threaded, permanent steel isolation casing will be installed to prevent mixing between potential monitoring intervals. Boreholes will be advanced according to the sequence above. Once the Upper Potomac Confining Unit (UPCU; clay layer) is encountered (confirmed by recovered drill cuttings), the permanent steel isolation casing will override the drill casing and be advanced 2 feet into the clay layer. The annular space between the permanent isolation casing and override casing will then be pressure tremie-grouted to the ground surface and will remain in-place. Grout will be allowed to set for a minimum of 24 hours before resuming drilling and the borehole will be advanced through the

isolation casing. Upon completion of the boring/monitoring well, the override casing will be retrieved and the remaining annular space between the well casing and isolation casing will be grouted to the surface.

If the UPCU is absent, the isolation casing will be grouted into a finer-grained (lower conductivity) interval of the UPCU Transition Zone (UPCUTZ). If both the UPCU and UPCUTZ are not observed during drilling, the isolation casing will be grouted approximately 2 feet into the top of the UPA upper sand as observed in the field based on lithologic changes in recovered soil cores during drilling. If the borehole is advanced beyond the desired isolation interval, the borehole will be allowed to collapse or backfilled with appropriate material (i.e., sand, grout, or bentonite).

Upon curing of the grout, the boring will be advanced to the Upper Potomac Dividing Clay (UPDC). Once the UPDC (clay layer) is encountered, an 8-inch to 10-inch diameter, threaded, temporary steel isolation casing will be advanced 2 feet into the clay layer. The isolation casing will then be pressure tremie-grouted to the ground surface. During grouting, the isolation casing will be recovered at a rate that ensures that the base of the casing remains below the tremied-grout surface. Grout will be allowed to set for a minimum of 24 hours before resuming drilling. If the UPDC is not encountered (i.e., no lithologic separation between the UPA upper and lower sand is observed), then there is no need for isolation casing between the UPA upper sand and UPA lower sand units for a UPA lower sand well, and the boring will be advanced until the top of the MPCU is encountered.

Recovered soil core in sample bags will be marked to verify proper orientation and sequence. The recovered core will be photo-documented, field screened for evidence of impacts from organic compounds using a photoionization detector (PID), and soil lithology will be logged by the field geologist. The drill rig and all drilling and sampling equipment coming in contact with subsurface soils will be decontaminated in accordance with procedures contained in Section 4.4.

4.3.2 Monitoring Wells Installation and Related Activities

A driller licensed by the DNREC will be utilized for the work. The driller will obtain drilling permits for the monitoring wells prior to commencement of the drilling activities.

4.3.2.1 Monitoring Well Installation

As described in Section 4.3.1.2 (see Table 3 and Figure 2), the proposed monitoring wells will be installed in borings advanced using Rotosonic drilling techniques. It is recommended that the first boring/well installed in the location of a proposed UPA upper and lower sand well pair be advanced to the top of the MPCU and be completed with a UPA lower sand well. Wells will be installed in borings that are separated from each other by between 15 and 25 feet horizontally.

The 5- to 7-foot screened interval for each well will be determined based on visual, olfactory and/or PID evidence of impacts. In the absence of impact evidence, the well will be screened across interval with the coarsest material in either the UPA upper or lower sand. More specifically, the placement of the well screens will be determined in the field, based on: 1) observed volatile organic impact based on organic vapor (i.e., PID) readings; and/or 2) visual evidence of impacts. If there is no evidence of either, then the screen interval will be set across the portion of the UPA (either upper sand or lower sand) with the coarsest materials.

Prior to well construction within the advanced borehole, the USEPA will be provided with a draft annotated boring log indicating the proposed well screen interval for their review and approval of the proposed screened interval. Due to concerns regarding limiting resident's access to their property during boring advancement and well installation, a quick response/approval (within two business hours) from the USEPA will be necessary.

For locations where the proposed well screen interval is shallower than the drilled depth of the borehole, the borehole will be backfilled/tremied with bentonite chips to within 6 inches to 1 foot of the base of the well. This practice is intended to avoid creation of a "filter pack" in the overdrilled borehole beneath the base of the constructed well.

Monitoring wells will be constructed with 2-inch diameter, 5- to 7-foot long, 0.010-inch (No. 10-slot) polyvinyl chloride (PVC) screen and appropriate lengths of 2-inch diameter solid PVC riser. A sand (filter) pack comprised of clean quartz sand will be placed in the annulus from within 6-inches to 1-foot below to 2 feet above the well screen interval. The sand pack material will be a #1 silica sand. A minimum of 0.5-foot thick #00 filter pack sand will be placed on top of the #1 sand pack, followed by a 2-foot thick seal of bentonite pellets tremied on top of the sand, and completed by a pressure tremie-grouted cement/5% bentonite slurry. Surface casings and concrete pads will be placed around each well, no sooner than 24 hours following well grouting. Surface completion, either flush-mount road boxes or standpipes with steel protective casings, will be dependent on the location of the monitoring well.

4.3.2.2 Monitoring Well Development

All new wells will be developed prior to the initiation of any groundwater sampling. Wells will be developed using surge blocks and continuous cycles of over-pumping and recovery until relatively clear water is produced, and field parameters (pH, specific conductance and turbidity) stabilize indicating good hydraulic communication with the surrounding water bearing zone. Field parameters will be measured with a calibrated water quality meter. Because these wells will be sampled for PFAS, PFAS-free extraction equipment and high-density polyethylene (HDPE) tubing will be used during development.

4.3.2.3 Monitoring Well Elevation and Location Survey

Monitoring wells will be surveyed by a surveyor licensed in the State of Delaware after installation for location and elevation including ground surface, top of PVC and top of steel casing elevations. Certain wells for which discrepancies exist between the ACL and DS&G survey data (see Table 3 in the Work Plan), or which may otherwise be suspect, will be re-surveyed. The survey datum will be consistent with existing datum used for the Site as follows: horizontal datum is Delaware State Plan Coordinate System North American Datum (NAD) 1983; and vertical datum is National Geodetic Vertical Datum (NGVD) 1929.

4.3.2.4 Natural Gamma Logging

Existing wells MW-38N, MW-22N and MW-49N will be logged using natural gamma downhole geophysics to evaluate lithology (sands and gravels) and presence (or absence) of the dividing clay (UPDC). This information will be used to update the cross sections to be included in the Additional Investigation report.

The wells will be logged using a spectral gamma probe lowered from the top of the well to the base of the well. The natural gamma signal will be recorded continuously. Data generated will be plotted for evaluation.

4.3.2.5 Vertical Flow Assessment

Approximately two weeks prior to purging and sampling wells screened across both the UPA upper and lower sands (see Table 4), an electromagnetic or spinner flow-meter will be used to log the vertical flow within the wells, and adjustments to proposed low-flow purging and sampling depths will be made if necessary.

A vertical flow meter will be deployed in wells with long-screen intervals to assess the ambient direction and velocity of flow within the screen interval of the well. This assessment will be performed for wells screened across different lithologies (particularly wells screened across both the UPA upper and lower sands) at the Site to evaluate the migration between lithologic units, if any. The vertical flow meter will not be used to calculate horizontal hydraulic conductivity and/or determine the hydraulic conductivity distribution of the screened interval.

To assess vertical flow within the well, the flow meter will be lowered to the base of the well and the well will be allowed to equilibrate for 10 minutes. Screening measurements will be made from the base of the well to one foot above the top of the screened interval at 1-foot increments for wells with 20 feet or less of screen and at two-foot increments for wells with more than 20 feet of screen. The readings will be recorded, tabulated and plotted for evaluation.

4.3.3 Monitoring Well Sampling Procedures

After well construction and development, the new monitoring wells will be allowed to stabilize and equilibrate with the aquifer for a minimum of two weeks prior to sampling. Due to the extremely low method detection

limits associated with PFAS analysis and the numerous potential sources of trace concentrations of PFAS, detailed operating procedures to reduce the potential for cross contamination and false positive sample results were developed for the groundwater monitoring program. As included in Attachment A, PFAS sampling activities will be performed in accordance with the general methods and procedures described in *SOP–1: General Field Methods for PFAS Sampling Programs*.

4.3.3.1 Water Level Measurement Procedures

Depth to water measurements should be taken from all wells indicated on Table 3 Proposed Monitoring Program within a time period (not to exceed 48 hours) that is not interrupted by severe changes in barometric pressure (+/- greater than 1 inch of mercury) or by precipitation events. The synoptic water level measurements will be performed AFTER collection of groundwater samples for all sampling events, due to the inclusion of PFAS as an analyte at the Site.

Depth to water will be measured in each monitoring well to the nearest 0.01-foot using an electronic depth-indicating sounder. All groundwater measurements will be made in reference to a control point of known elevation at the top of the well casing. If a total depth measurement is necessary, to confirm well construction information for example, it will be taken after any scheduled sample collection to minimize potential cross-contamination and disturbance to sediments, which may have accumulated in the bottom of the well.

The water level meter will be decontaminated between locations using certified PFAS-free de-ionized (DI) water.

4.3.3.2 Low-Flow Groundwater Sampling Procedures

Groundwater samples will be collected using the low-flow purge and sampling technique[2] consistent with previous work at the Site. Prior to sampling, each monitoring well will be purged using a dedicated or decontaminated 2-inch submersible pump (Grundfos RediFlo, Proactive or equivalent) and high-density polyethylene (HDPE) tubing dedicated to each well. The pump intake will be placed consistent with past sampling intervals (see Table 4). Wells are typically purged at a rate of approximately 200 to 500 milliliters per minute (ml/min) with a goal of less than 0.1 meters (0.3 feet) of drawdown during purging. Best efforts will be made to minimize well drawdown by adjusting the flow when necessary and frequently monitoring the water level during purging. A minimum of 3 feet of water will be maintained over the pump intake at all times to avoid the risk of entrainment of air and pump overheating.

[2] The procedure is based upon either the USEPA Region II document entitled "Groundwater Sampling Procedure, Low Stress (Low Flow) Purging and Sampling" dated March 20, 1998 (USEPA, 1998) or the USEPA document entitled "Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures" dated April 1996 (USEPA, 1996a).

For the PFAS groundwater sampling event, the ECs will purge each well using low-flow sampling procedures in accordance with this SAP and *SOP-2: PFAS Program Monitoring Well Purging and Sampling Protocols* (Attachment A) prior to groundwater sample collection.

During purging, field parameters (temperature, pH, oxidation-reduction potential (ORP; measured using a platinum electrode), turbidity, specific conductance and dissolved oxygen [DO]) will be monitored with a Horiba U-52 instrument (or equivalent). Measurements will be collected using a flow-through cell device to minimize sample exposure to the atmosphere. All measurements will be recorded on the Low-Flow Groundwater Purge/Sample Field Information Form (Attachment B) or other equivalent low-flow purge and sampling forms. Measurements will be collected approximately every 5 minutes. For water quality stabilization purposes, measurements will not be evaluated for stabilization until at least one tubing volume (including pump and flow through cell volume) have been purged from the well [3]. Once removal of one tubing volume has been achieved, stabilization will be based on three consecutive readings within the following ranges:

- Temperature: +/- 10%
- pH: +/- 0.1 Standard Units
- Conductivity: +/- 3%
- ORP: +/- 10 millivolts (mV)
- DO: +/- 10% (or +/- 0.1 milligrams per liter [mg/L] if less than 1.0 mg/L)
- Turbidity: +/- 10% (or three consecutive readings below 50 Nephelometric Turbidity Units [NTUs])

Once purging is complete, the discharge tubing will be disconnected from the flow-through cell and samples will be collected directly from the end of the discharge tubing. Certified-clean sample bottles, provided by the laboratory, will be filled by allowing the pump discharge to flow gently down the inside of the bottle with minimal agitation. Each pre-labeled bottle will be capped as it is filled. VOC samples will be collected first, at a flow rate of 100 to 250 ml/min, taking steps to eliminate all headspace in the vials. Immediately after filling, each VOC vial will be checked by inverting the vial and tapping the side of the vial to check for air bubbles. If air bubbles are discovered, the vial will be discarded and a new vial with be filled and checked for bubbles. The above procedure will continue until a minimum of two VOC vials per sample location are collected.

During the PFAS sampling event, samples for PFAS analysis will be collected subsequent to VOC sample collection, otherwise samples for metals analyses will be collected subsequent to VOC sample collection.

[3] This procedure is based on Ground-Water Sampling Guidelines for Superfund and RCRA Project Managers Ground-Water Sampling Guidelines for Superfund and RCRA Project Managers dated May 2002, written by Yeskis, Douglas and Zavala, Bernard (Yeskis, Zavala, 2002).

Consistent with Site practices over more than the last 10 years and to maintain a consistent data set, metals samples will be collected for analysis of total and dissolved metals. The filtered (dissolved) metals samples will be collected using an inline 0.45-micron filter attached to the end of the discharge tubing without a flow-through cell in-place. While it is anticipated that wells will have a turbidity less than 10 NTUs (low-flow guidance allows for dissolved metals analysis if turbidity is greater than 10 NTUs), it is possible that entrained particles (metal flakes due to corrosion of old steel extraction well casings) will included in the total metals samples. Therefore, total as well as dissolved metals samples should be collected and analyzed.

The samples will be preserved according to method-specific requirements, and promptly placed in a cooler with wet ice and maintained at approximately 4 degrees Celsius (°C). Following sampling, the samples will be shipped under COC procedures to the analytical laboratory(ies).

4.3.3.3 Volume Average Purging Using Submersible Pumps

Following low-flow purge and sampling during the first 2019 monitoring event, a subset of wells will be purged and sampled as a one-time event using volumetric averaging (3-well-volume purging) followed by sample collection (Golder and RAI, 2018b; see Table 4; USEPA also requested the comparative analysis be performed for an upper/lower sand pair (USEPA, 2019a); therefore, new well pair WL-1U / WL-1L is included in this evaluation). Prior to sampling, each monitoring well will be purged of 3 well volumes using a dedicated or decontaminated 2-inch submersible pump (Grundfos RediFlo™, Proactive™ or equivalent) and HDPE tubing dedicated to each well. The pump intake will be placed at the midpoint of the well screen.

Using the well construction information, the volume of standing water in each casing will be calculated using the following equation:

Standing Water Volume = ((Well depth) – (Water level))*(Casing Volume/foot))

Casing Volumes

2-inch casing	4-inch casing	6-inch casing
0.163 gal/ft	0.653 gal/ft	1.47 gal/ft

Wells are typically purged at a rate greater than one liter per minute (l/min). The wells for which this method will be used recharge quickly; therefore, a minimum of 3 feet of water will be maintained over the pump intake at all times to avoid the risk of entrainment of air and pump overheating. For the PFAS groundwater sampling event, also refer to *SOP-2: PFAS Program Monitoring Well Purging and Sampling Protocols* (Attachment A) prior to groundwater sample collection.

During purging, field parameters (temperature, pH, oxidation-reduction potential (ORP; measured using a platinum electrode), turbidity, specific conductance and dissolved oxygen [DO]) will be monitored with a Horiba U-52 instrument (or equivalent). Measurements will be collected from the initial well volume of water, and following removal of each well volume. All measurements will be recorded on the Volume Average Groundwater Purge/Sample Field Information Form (Attachment C) and/or in field notebooks. This procedure will be repeated until at least 3 (minimum if field parameters meet stabilization criteria), but no more than 5 standing water volumes have been evacuated.

Once purging is complete, samples will be collected directly from the end of the discharge tubing. Certified-clean sample bottles, provided by the laboratory, will be filled by allowing the pump discharge to flow gently down the inside of the bottle with minimal agitation. Each pre-labeled bottle will be capped as it is filled. VOC samples will be collected first, at a flow rate of 100 to 250 ml/min, taking steps to eliminate all headspace in the vials. Immediately after filling, each VOC vial will be checked by inverting the vial and tapping the side of the vial to check for air bubbles. If air bubbles are discovered, the vial will be discarded and a new vial with be filled and checked for bubbles. The above procedure will continue until a minimum of two VOC vials per sample location are collected.

During the PFAS sampling event, samples for PFAS analysis will be collected subsequent to VOC sample collection, otherwise samples for metals analyses will be collected subsequent to VOC sample collection. Consistent with Site practices over more than the last 10 years and to maintain a consistent data set, metals samples will be collected for analysis of total and dissolved metals. The filtered (dissolved) metals samples will be collected using an inline 0.45-micron filter attached to the end of the discharge tubing without a flow-through cell in-place. While it is anticipated that wells will have a turbidity less than 10 NTUs (low-flow guidance allows for dissolved metals analysis if turbidity is greater than 10 NTUs), it is possible that entrained particles (metal flakes due to corrosion of old steel extraction well casings) will included in the total metals samples. Therefore, total as well as dissolved metals samples should be collected and analyzed.

The samples will be preserved according to method-specific requirements, and promptly placed in a cooler with wet ice and maintained at approximately 4°C. Following sampling, the samples will be shipped under COC procedures to the analytical laboratory(ies).

The sample analytical results from the different methodologies will be tabulated along with their sampling depths to facilitate direct comparison of the information. The data will also be compared using an RPD calculation. The results will be included in the first 2019 semi-annual monitoring event report for the Site. This one-time event activity is being conducted to determine that low-flow purging and sampling is appropriate for long-screen wells at the Site.

4.3.3.4 Volume Average Purging Using Bailers

Due to the viscosity of the leachate in the gas vents, bailers will be used to purge and collect gas vent samples for PFAS analysis. Past experience with purging and collection of leachate samples from these gas vents indicates that due to the very slow recharge of leachate into the gas vents, only one to three well volumes can be purged within a 24-hour period. Therefore, the standard protocols for volume average purging using bailers was modified for purging and collecting samples from the gas vents.

The gas vents will be purged using a dedicated or disposable, bottom-filling, non-Teflon bailer. Using the gas vent construction information, the volume of standing water in each casing will be calculated using the following equation:

Standing Water Volume = ((Well depth) – (Water level))*(Casing Volume/foot))

Casing Volumes

2-inch casing	4-inch casing	6-inch casing
0.163 gal/ft	0.653 gal/ft	1.47 gal/ft

Nylon well rope will be securely tied to the new or dedicated bailer. The bailer will be gently lowered into the water column in order to minimize disturbance. Once the bailer fills, it will be slowly pulled up. Field parameter readings (pH, DO, conductivity, temperature, ORP, and turbidity) will be collected from the initial bailer of water, and following removal of each well volume. All measurements will be recorded on the Volume Average Groundwater Purge/Sample Field Information Form (Attachment C) and/or in field notebooks. This practice will be repeated until one of the following occurs:

1. At least 3 (minimum if field parameters meet stabilization criteria), but no more than 5 standing water volumes have been evacuated.

2. Gas vent is purged "dry" (i.e., less than approximately 6 inches of leachate remains in the gas vent). If a gas vent is purged "dry", then it will be given up to 24 hours to recharge before samples are collected.

The sampling locations were originally constructed for gas venting, therefore, the static water/leachate level within the vents may be at, above or below the top of the screen, and in some locations minimal, if any, leachate is present within the gas vent. The samples will be collected as soon as there is a sufficient recharge volume to fill the sample bottles. The bailer will be slowly lowered down the well into the top of the water column such that unnecessary disturbance to the sample does not take place.

Certified-clean sample bottles, provided by the laboratory, will be filled by allowing the water to flow out of the bottom of the bailer and gently down the inside of the bottle with minimal agitation. Each pre-labeled bottle will be capped as it is filled. The samples will be preserved according to method-specific requirements, and promptly placed in a cooler with wet ice and maintained at approximately 4°C. Following sampling, the samples will be shipped under COC procedures to the analytical laboratory.

4.3.4 AWC Well Sampling

AWC samples its operating production wells monthly or quarterly depending on its monitoring and reporting requirements. For the parameters and locations listed on Table 3, AWC will allow Golder to access and collect samples for analysis. Extraction wells will be sampled as close to the well source as possible. Wells that are on-line will be sampled by first discharging approximately 5 liters from the piping lines. Off-line AWC production wells will not be sampled.

Following purging, field parameters will be measured as grab samples with a Horiba U-22 instrument (or equivalent). All measurements will be recorded on the Low-Flow Groundwater Purge/Sample Field Information Form (see Attachment B) or other equivalent low-flow purge and sampling forms. Once purging is completed, samples will be collected directly from the port. Samples for VOC will be collected first, by allowing the water to gently flow down the inside of the vial, taking steps to eliminate all headspace in the vials. Immediately after filling, each VOC vial will be checked by inverting the vial and tapping the side of the vial to check for air bubbles. If air bubbles are discovered, the vial will be discarded and a new vial with be filled and checked for bubbles. The above procedure will continue until a minimum of two VOC vials per sample location are collected.

During the PFAS monitoring event, samples for PFAS analysis will be collected subsequent to VOC sample collection, otherwise samples for metals analyses will be collected subsequent to VOC sample collection. Metals samples will be collected for analysis of total and dissolved metals. The filtered (dissolved) metals samples will be collected using an in-line 0.45-micron filter attached to the end of the discharge tubing without a flow-through cell in-place.

The samples will be preserved according to method-specific requirements, and promptly placed in a cooler with wet ice and maintained at approximately 4°C. Following sampling, the samples will be shipped under COC procedures to the analytical laboratory.

4.3.5 Collection of Split Samples

It is anticipated the USEPA's contractor (CDMSmith) will collect split samples for VOCs and metals analyses during the first groundwater monitoring event in which the new monitoring wells are sampled (anticipated in July 2019) (USEPA, 2019b). It is also anticipated the USEPA's contractor will collect split samples for

PFAS analysis during the next semi-annual groundwater monitoring event in which PFAS samples are collected for analysis (anticipated in October 2019) (USEPA, 2018c).

For the split sampling locations selected by the USEPA's contractor, RAI will purge the monitoring wells using the procedures outlined in the SAP, then RAI will collect samples for analysis in bottles supplied by TestAmerica (VOCs and metals) or Eurofins (PFAS) and the USEPA's contractor will collect samples for analysis into bottles supplied by the laboratory that the USEPA intends to use for its analyses. RAI and the USEPA's contractor will alternate filling of bottles for analysis to acquire split samples and/or duplicate samples.

4.4 Decontamination

Decontamination procedures in this section are intended for use by field personnel for cleaning sampling, drilling and other equipment in the field. Deviations from these procedures should be documented in the field records and investigative reports. Specifications for standard decontamination materials follow. These materials will be used, as appropriate, for non-dedicated equipment used during sample collection (e.g., pumps).

- Soap will be a phosphate-free laboratory detergent such as Liquinox® or Alconox®. Use of other detergent must be documented in the field log books and investigative reports.
- Solvent will be pesticide-grade isopropanol. Use of a solvent other than pesticide-grade isopropanol for equipment cleaning purposes must be justified and documented in field log books and investigation reports.
- Tap water may be used from the municipal water treatment system. Use of an untreated potable water supply is not an acceptable substitute for tap water.
- Deionized water is tap water that has been run through a standard deionizing resin column. It is commercially available.
- Distilled water is tap water that has been distilled. It is commercially available.
- Analyte-free water is tap water that has been treated with activated carbon and a standard deionizing resin column. At a minimum, the finished water should contain no constituents above the laboratory reporting limits that are being analyzed for as part of the remedial investigation.
- Other solvents may be substituted for a particular purpose if required. For example, removal of concentrated waste materials may require the use of either pesticide-grade hexane or petroleum ether. After the waste material is removed, the equipment must be subjected to the standard cleaning procedure. Because these solvents are not miscible with water, the equipment must be completely dry prior to use.

Solvents, laboratory detergent, and rinse waters used to clean equipment will not be re-used during field decontamination and will be stored in Department of Transportation (DOT)-approved 55-gallon drums. These materials will be treated as investigation-derived waste (IDW). See Section 4.5 for proper handling and disposal of these materials.

4.4.1 PFAS Decontamination

When decontaminating non-dedicated equipment used to sample PFAS, use the following procedure:

- Rinse thoroughly with Citranox solution
- Rinse thoroughly with DI water (certified PFAS free)
- Rinse with methanol (certified PFAS free)
- Rinse with DI water
- Allow to air dry
- Submersible pumps used to sample PFAS, will be decontaminated at the monitoring well location to be sampled. Once the pump is decontaminated, it will be placed directly into the monitoring well and lowered to the sample interval to avoid accidental PFAS cross-contamination.

4.4.2 Drilling Equipment

The procedures in this section are to be used for all non-dedicated drilling equipment. All decontamination procedures in this section will be performed on a decontamination pad, constructed to the specifications in this section.

4.4.2.1 Decontamination Pad Specifications

Decontamination pads constructed for field cleaning of sampling and drilling equipment should meet the following minimum specifications:

- The pad should be constructed in an area known or believed to be free of surface contamination.
- Ideally, the pad should be located very close to a potable water source.
- The pad should not leak excessively.
- If possible, the pad should be constructed on a level, paved surface and should facilitate the removal of wastewater. This may be accomplished by either constructing the pad with one corner lower than the rest, or by creating a sump or pit in one corner or along one side. Any sump or pit should also be lined.
- Water should be removed from the decontamination pad as needed.
- A temporary pad should be lined with a water impermeable material. This material should be either easily replaced (disposable) or repairable.

At the completion of site activities, the decontamination pad should be deactivated. The pit or sump should be backfilled with the appropriate material designated by the project field leader. No solvent rinsates will be placed on the pad. Solvent rinsates should be collected in separate containers for proper disposal.

4.4.2.2 Decontamination Procedures

The procedures in this section are to be employed prior to each use and prior to de-mobilization for all non-dedicated drilling equipment:

1. Clean with tap water and soap using a brush to remove obvious particulate matter and surface films.
2. Rinse thoroughly and power wash with potable water.
3. Rinse non-dedicated equipment that might contact samples with distilled water. If distilled water is not available, equipment should be allowed to completely dry.
4. Decontamination water should be containerized and as described in Section 4.5.

4.4.3 Non-Dedicated Sampling Equipment

The procedures in this section are to be employed prior to each use for all non-dedicated sampling equipment used to collect groundwater samples, with the exception of non-dedicated submersible pump:

1. Clean with tap water and soap using a brush to remove obvious particulate matter and surface films.
2. Rinse thoroughly with tap water.
3. Rinse thoroughly with DI or distilled water.
4. Rinse thoroughly with solvent (pesticide-grade isopropanol) unless made of PVC or plastic. These items are not to be solvent rinsed.
5. Rinse thoroughly with analyte-free water. If analyte-free water is not available, equipment should be allowed to completely dry.
6. Decontamination water should be containerized and as described in Section 4.5.

4.4.4 Groundwater Sampling Equipment (Non-Dedicated Submersible Pump)

Non-dedicated groundwater sampling equipment used for the purging and sampling (such as a submersible pump) will be decontaminated prior to sampling each well. The submersible pump will not be removed from the well between purging and sampling operations. The pump and tubing (including support cable and electrical wires that are in contact with the sample) will be decontaminated by the procedure described below. It should be noted that the outside of the pump will be decontaminated consistent with the procedure described above. In addition, decontamination fluids will be pumped from buckets through the pump as follows:

1. Flush the pump with potable water to remove any sediment that may be trapped in the pump.
2. Flush the pump with a weak, non-phosphate detergent solution (approximately 5 gallons).
3. Flush the pump with tap water to remove all the detergent solution. Generous amounts of tap water (at least 3 pump volumes) should be used to ensure that detergent and any sediment that may be trapped in the pump does not remain in the pump.

4. Flush the pump with deionized or distilled water (during PFAS-monitoring events, use certified PFAS-free DI water);
5. Flush the pump with isopropyl alcohol (during PFAS- monitoring events, use certified PFAS-free methanol). Use sparingly to minimize presence of this decontamination fluid in the samples; and
6. Flush the pump with analyte-free water (during PFAS- monitoring events, use certified PFAS-free DI water). Generous amounts of water (at least three pump volumes) should be used to remove as much of the isopropyl alcohol (or methanol) as practical.
7. Decontamination water should be containerized and as described in Section 4.5.

4.5 Investigation-Derived Waste

IDW generated during remedial investigation field activities include: soil, decontamination water and solvent, purge water, well development water, and personal protective equipment (PPE). Each type of IDW will be handled as described below and stored on the NCC Treatment Plant property until off-Site disposal arrangements are made:

4.5.1 Soil

All excess soil generated from drilling activities will be retained in 55-gallon drums or roll-offs and labeled as "Drill Cuttings". Once a container has been filled, it will be sealed, dated, numbered, labeled, and recorded in the field log book.

4.5.2 Water

All decontamination, purge, and well development water will be collected in five-gallon buckets, 55-gallon drums or 250-gallon totes for transfer to a larger holding tank to allow for sediment to settle out and arrangements to be made for disposal. Storage containers will be labeled as "IDW-Water" and recorded in the field log book.

4.5.3 Disposable PPE

Disposable PPE generated during investigations will be placed in a 55-gallon drum and labeled "PPE". Once a drum has been filled, it will be sealed, dated and numbered, labeled, and recorded in the field log book.

4.5.4 Labeling

IDW container labels will include:

- Nature of the IDW (soil, purge water, etc.)
- ID of the well or wells that provided the IDW
- Date filled
- Container number, as recorded in the field log book

The drums, roll-offs, totes and other containers will be staged on the NCC treatment plant property. At the end of the field activities, IDW will be disposed of in accordance with all applicable state and federal regulations.

4.6 Sample Handling and Custody

Table 10 presents the types of analytical SOP reference, methods, containers, volumes, preservations, and hold times that are required for samples. The laboratory quality manuals (QMs) are provided in Attachments D-1 and E-1. Sample container labels will include the following information:

- Project (site) name
- Sample point identification number
- Date and time the sample was collected
- Preservative (if any)
- Analyses to be performed
- Initials of the sampler

Immediately after sample collection, sample bottles will be placed in a cooler with wet ice and completed COC form. The samples must be maintained at approximately 4° C after collection. COC forms will be completed and will accompany the samples at all times. The COC form and field log book should include:

- Sample identification number and matrix
- Project or site name or number
- Sampler's name or initials
- Sample collection date and time (military time)
- Designation as a grab or composite sample
- Requested analysis
- Any special comments (i.e., samples will be filtered by laboratory upon receipt)
- Any preservatives added to the sample

When shipping samples to the laboratory, sample bottles and requested analyses should be noted on the COC form. The field team leader is responsible for sample handling and documentation requirements. One member of the sampling team should sign the COC form relinquishing custody to the laboratory. If using an overnight courier service, record the tracking number on the COC. The COC form should be sealed inside the shipping container with the samples. The paperwork should be sealed inside a plastic bag to prevent damage from water condensation. The courier does not need to sign the COC form if it is sealed within the shipping container using custody seals. Once samples are transported to the analytical laboratory, custodial responsibility is transferred to the laboratory.

4.7 Analytical Methods

The laboratories will perform sample analyses in accordance with the following USEPA method guidelines:

- VOCs following USEPA SW846 (USEPA, 1996b) Method 8260C VOCs by Gas Chromatography/Mass Spectrometry (GC/MS) (August 2006; USEPA, 2006)
- Total TAL metals, dissolved manganese, and dissolved iron following USEPA SW846 Method 6010D Inductively Coupled Plasma-Atomic Emission Spectrometry (July 2014; USEPA, 2014)
- PFAS following USEPA Method 537, Determination of Selected Perfluorinated Alkyl Acids in Drinking Water by Solid Phase Extraction and Liquid Chromatography/Tandem Mass Spectrometry (LC/MS/MS), Rev 1.1 (September 2009; USEPA, 2009), modified[4]
- Sulfide following Standard Method (SM) 4500-S2-E Sulfide, Iodometric Method (APHA, 2012)
- Alkalinity following SM 2320B, Titration Method (APHA, 2012)
- Nitrogen, ammonia following SM 4500 NH_3-H, Flow Injection analysis (APHA, 2005)
- Chloride, Nitrate, Nitrite, and Sulfate following USEPA Methods for Chemical Analysis of Water and Wastes (MCAWW) Method 300.0 Determination of Inorganic Anions by Ion Chromatography (USEPA, 1993), USEPA SW-846 (USEPA, 1996b) Method 9056A and SM 4110-B (APHA, 2012)
- Ferrous Iron following SM 3500-Fe D Iron (APHA, 1992)

SOP documentation from TestAmerica and Eurofins[5] for each of these methods are included in Attachments D-2 and E-2, respectively. Please see Table 11, Analytical SOP References, for the analytical group, reference number and title of each included SOP.

4.8 Quality Control

This section describes the various Quality Assurance/Quality Control (QA/QC) samples that will be collected in the field and analyzed in the laboratory and the frequency at which they will be performed. QA/QC samples which will be collected will consist of field duplicates, trip blanks, rinsate blanks, and MS/MSDs (see Table 12). As QA/QC sample requirements vary by analytical method, SAP Tables 5 through 8 detail specific QC sample requirements. These QA/QC samples are described briefly in the following sections.

During the PFAS groundwater sampling event, the ECs will collect equipment blanks, field duplicates, field blanks, and trip blanks, as summarized on Table 8 for QA/QC purposes. QA/QC samples will be collected

[4] As stated in an email from the USEPA dated December 18, 2018, "[b]ased on laboratory documents submitted to EPA for review in emails dated October 1 and November 27, 201[8], EPA approves the use of Eurofins' modified Method 537 for the analysis of groundwater. (USEPA, 2018d)

[5] Eurofin's SOPs for the PFAS method are confidential and proprietary, as is the case with other labs at this time, because it is a modified version of USEPA Method 537. Method 537 as written is strictly a drinking water method. A coversheet from Eurofins demonstrating that the SOP exists, as well as their more generalized boiler plate documents outlining the analysis summary and PFAS collection considerations are included as Attachment E-2. Additional information regarding Eurofins' modified PFAS method was provided to the USEPA for review and approval as noted above.

in accordance with *SOP-3: Quality Assurance / Quality Control Protocols for PFAS Sampling Programs* (Attachment A). These samples will be submitted to Eurofins for analysis of PFAS via USEPA Method 537 Revision 1.1 Modified.

4.8.1 Field Duplicates

Field duplicates will be collected at a frequency of one per 20 primary samples per matrix. Field duplicates are collected by sampling the same location twice, but are assigned a unique sample identification number. When collecting field duplicate samples, the sample containers for each analytical parameter should be filled for both the primary and duplicate sample before the jars for the next analytical parameter are filled.

4.8.2 Trip Blanks

Trip blanks will be collected at a frequency of one per shipping event. Trip blanks are used to verify that the VOC and/or PFAS bottles and samples are not contaminated in transit between the laboratory to the Site, while on Site, and from the Site back to the laboratory. The laboratory will supply pre-prepared trip blanks. Trip blanks should accompany the VOC samples throughout the event from collection through shipment to the laboratory and are recorded on the COC along with the primary samples. Trip blanks are shipped along with each cooler that contains aqueous VOC samples. For the PFAS sampling event, see SOP-3 for additional requirements.

4.8.3 Rinsate Blanks

Rinsate blanks are collected for all required analyses at a frequency of one per day per type of non-dedicated sampling equipment which comes in contact with the sample. Rinsate blanks are used to verify that decontamination of field equipment was sufficient. Rinsate blanks are prepared in the field using lab supplied demonstrated analyte-free water. The water is poured over and through each type of sampling equipment and collected in labeled laboratory supplied bottles. Rinsate blanks are recorded on the COC along with the primary samples. For the PFAS sampling event, see SOP-3 (Attachment A) for additional requirements.

4.8.4 Field Blanks

As described in SOP-3, field personnel shall submit of one field blank per day of sampling during the PFAS sampling events. Field blanks shall consist of PFAS-free water containerized in an HDPE sample container filled at the laboratory prior to beginning the field program. Field blank sample containers shall be opened during the collection of a sample and the laboratory-supplied, PFAS-free water contained therein shall be poured directly into a laboratory-supplied HDPE sample container, then resealed. Field blank container lids shall remain in the hand of field personnel until replaced on the sample container. Sample container labels shall be completed as described above.

4.8.5 MS/MSDs

MS/MSDs are collected for all required analyses at a frequency of one per 20 primary samples per matrix. MS/MSD samples are prepared and run by the laboratory to verify the effectiveness of sample preparation procedures in measuring chemicals of interest from the matrix material. Additional sample volume is collected from a location and submitted to the laboratory for analysis. MS/MSD samples are recorded on the COC along with the primary samples. For the PFAS sampling event, see SOP-3 (Attachment A) for additional requirements.

4.8.6 Internal QC Samples

Internal QC checks have been developed to help ensure accuracy and precision during field sampling and measurement as well as laboratory analysis. Field checks will be performed regularly. Laboratory QC checks will be performed in accordance with the specific analytical methods.

Field measurements will be made in duplicate at a frequency of one in twenty measurements taken. These duplicate measurements must agree +20 percent. If the duplicate measurements do not meet this criterion, the instrument will be recalibrated and the measurements will be retaken. Field measurements will be recorded in the field notebooks or field information forms and later entered into summary tables.

Details of the internal QC checks utilized by the laboratory will be found in each specific laboratory QM and the published analytical methods. Laboratory QC samples will be analyzed at a frequency of one per twenty analytical samples or at a frequency dictated by the methods. These QC samples will be used to determine if results may have been affected by field activities or procedures used in sample transportation or if matrix interferences are an issue. Assessment of laboratory QC will take into account the PARCCS criteria specified in Tables 5 through 8.

Applicable statistics will be calculated following the laboratory SOPs, which can be found in Attachments E and F, and Section 3.0 Quality Objectives and Criteria. The laboratories routinely re-evaluate QC criteria using the procedures in their respective laboratory QMs. Analytical data that fall outside QC criteria will be qualified as discussed in Section 5.0 Data Validation and Usability.

4.9 Instrument/Equipment Testing, Inspection, and Maintenance

Preventive maintenance of equipment is essential if project resources are to be utilized in a cost-effective manner. Preventive maintenance will sustain the accuracy of measurement systems, minimize downtime, and provide inventory control of critical spare parts, backup systems, and other necessary equipment. The field sampling team will maintain an inventory of replacement parts for field instruments and will routinely perform preventive maintenance or repair. Spare parts that often require replacement will be kept on hand at the Site during field activities. The preventive maintenance approach for equipment used in field for sampling, monitoring, and testing includes checking batteries and electrodes, checking condition of meters,

checking sample bottles for cleanliness and breakage, and that a reasonable supply of bottles, batteries, probes, calibration solution, and supplies are on-hand to avoid unnecessary delays in the field.

Preventive maintenance of laboratory equipment and hardware are described in specific sections of each laboratory QM included in Attachment D. TestAmerica discusses these procedures in Section 20 of their laboratory QM. More than one instrument is generally available for each type of analysis in case the initial instrument malfunctions or does not meet the required measurement criteria. Laboratory personnel or qualified manufacturer representatives will perform preventive maintenance and repair. The laboratory will retain logbooks documenting preventative maintenance and repair for each instrument.

4.10 Instrument Calibration and Frequency

4.10.1 Field Calibration

The calibration and maintenance of field equipment will be the responsibility of the field sampling team. Field instruments, such as meters for measuring field parameters, will be standardized/calibrated in accordance with the manufacturers' recommendations against National Institute of Standards and Technology (NIST) traceable standards, where appropriate. During sampling, calibration checks will occur at a minimum of two times a day (beginning of each day and at least every four hours of operation). Appropriate calibration records will be maintained in project field log books, groundwater sample field information forms, or on calibration forms. A minimum of a two-point calibration will be performed for each parameter being calibrated. The field team leader is responsible for ensuring that calibrations are properly performed at the appropriate frequency.

4.10.2 Photovac Microtip Photoionization Detector (PID)

A MiniRAE 3000 (or equivalent) will be used to monitor VOC concentrations in ambient air during intrusive field activities (i.e., groundwater sampling and well installation). The MiniRAE 3000 is a microprocessor controlled PID. The instrument normally operates with a 10.6 electron volt (eV) lamp; however, 9.8 and 11.7 eV lamps are available as options. The detector is capable of measuring concentrations down to about 1 part per million (ppm) sensitivity for certain compounds. An 11.7 eV lamp will be used on the PID as gross screen for VOCs since the primary VOCs at the Site have good responses to the 11.7 eV lamp. The PID cannot be used to identify unknown substances, it can only quantify/estimate VOC vapors. Winds and high humidity will affect measurement readings. Foggy or high humidity conditions can cause condensation on the lamp, thus affecting measurements.

4.10.2.1 Operational Information

The instrument will be taken into the field fully charged and operated according to manufacturer's instructions. Turn the instrument on by pressing the “MODE” key for one second and release. The pump will start and the message "Warming up now, please wait" will be displayed for about one minute.

The MiniRAE 3000 has two operation modes:

- Search – With the instrument in Search Mode, it only samples when the use activates sampling.
- Hygiene – the instrument is programmed to operate in Hygiene Mode as its default. This provides the most commonly needed features while requiring the fewest parameter adjustments.

The MiniRAE is factory calibrated with standard calibration gas, is programmed with default alarm limits and will be field-calibrated using Isobutylene gas. The keypad is used to set up and calibrate the MiniRAE. The instrument must be calibrated against a dynamic standard in order to display concentrations in units equivalent to parts per million by volume (ppmv). Clean outdoor air is suitable as 'zero gas'. Isobutylene should be used as the calibration gas and calibration should be conducted in a well-ventilated, clean air environment. Note that cylinders of compressed gas must be handled with care.

4.10.2.2 Instrument Calibration and Frequency

Following is a description of the calibration procedure:

- Ensure that you are in an area with clean air, away from any exhaust or other potential vapor sources
- Press [N-] and [MODE] simultaneously for 3 seconds to enter Programming Mode
- Press [Y+] to select "Calibrate/Select Gas" menu item
- Press [Y+] to select "Zero Cal?" The display will then read "Apply zero gas"
- Press [Y+] the display will read "Zeroing" for 30 seconds
- While the MiniRAE is collecting the fresh air calibration, prepare the span gas:
  1. Attach a Tedlar bag to the canister of Isobutylene via tubing and regulator
  2. Open the bag valve
  3. Open the gauge valve. DO NOT ALLOW TEDLAR BAG TO OVERFILL
  4. When bag is filled, close regulator valve, then close bag valve
- When zero span is completed, attach Tedlar bag to MiniRAE via tubing
- Press [Y+] to select "Span Cal?"
- When display reads "Apply gas now!", open bag valve. Display will then show "wait ...30" with a countdown timer while monitor performs the calibration.
- When done, the display should read calibrated value (for Isobutylene, this should be 100 ppm)
- The instrument is calibrated and ready for use

The MiniRAE will alarm for the following conditions:

- Measured gas concentration exceeds the programmed alarm limits, which for Isobutylene are:

Calibration Gas	Calibration Span Concentration		Low	High	Time Weighted Average	Short Term Exposure Limit
Isobutylene	100 ppm	Concentration	50	100	100	250
		Alarm	2 beeps/flashes per second	3 beeps/flashes per second	1 beep/flash per second	1 beep/flash per second

- Battery voltage falls below 4.4 V (there will then be approximately 20-30 minutes of operating time remaining)
- Ultraviolet (UV) lamp failure
- Pump stalls
- Datalog memory is full

4.10.3 Laboratory Calibration

Sample results should be within the calibration range of the instrument. Samples which do not contain concentrations of target analytes that exceed the instrument calibration range should be analyzed undiluted to achieve the lowest possible reporting limits. However, samples containing elevated levels of target analytes cannot be analyzed undiluted because the calibration range of the method would be exceeded. Such samples will require analysis at dilutions which would result in elevated reporting limits.

The major chemical analytical equipment used for this project are described in each laboratory's QM and the individual analytical methods, provided as Attachments D and E. Each laboratory's QM provides information regarding types of equipment used by the laboratory facility. Calibration procedures will follow published analytical methodologies. Each laboratory's QM references the specific methodologies or laboratory SOPs for calibration procedures. The laboratory will document sources for calibration material; for example, USEPA repository, Supelco© or equivalent. The laboratory QM also describes the procedures used to document equipment repair and maintenance.

4.11 Inspection/Acceptance of Supplies and Consumables

Sampling equipment will be inspected prior to use to ascertain proper operation and create a safe working environment. The laboratories chosen for this project have preventative maintenance and health and safety programs to ensure proper execution of project work.

4.12 Non-direct Measurements

Non-direct means of data acquisition refers to the use of non-measurement sources such as computer databases, spreadsheets, programs and literature files. ACL does not intend to obtain information from non-measurement sources for decision-making regarding this project.

4.13 Data Management

Data collection during this project will be retained in an electronic format. Specific data management activities are as follows:

- Field Sample Collection Forms:
  - Data will be transcribed from field forms or notebooks and tabulated, as appropriate, using a spreadsheet or database program.
  - Data entry will be checked to ensure no transcription errors occurred.
- COC Forms:
  - COC forms will be reviewed by the field staff prior to sample submission to the laboratory to verify that the COC matches the cooler contents.
  - COC forms will also be reviewed after sample submission to the laboratory by the QA manager or designee to verify that the sampling plan is being followed.
- Laboratory Sample Receipt Documentation:
  - The QA manager or designee will review the laboratory sample receipt documentation and compare to the COC. If discrepancies are found, the QA manager or designee will contact the field staff and laboratory to resolve any inconsistencies.
  - Communications concerning changes to the sample identifications and required analysis, including telephone memoranda and emails, will be saved to project files by the EC.
- Final Chemistry Analytical Data Documentation:
  - Analytical data packages will be verified internally by the laboratory performing the work for completeness prior to submittal to the EC.
  - The QA manager or designee will verify that the analytical data packages contain the information required for data validation upon receipt.
  - The data package elements required are described in Section 2.5 Documents and Records.
  - An electronic database, as well as validated qualifiers, will be kept on the project database, using Earthsoft's EQuIS database structure, by the EC. Database entries will be checked for correctness and completeness.

5.0 ASSESSMENT AND OVERSIGHT

5.1 Assessments and Response Actions

Assessment of activities or procedures will be the responsibility of the personnel performing such activities and procedures. For field measurements, the field team leader will be responsible for assessment while the laboratory analyst and sample custodian will be responsible for assessment within the laboratory. The assessment of activities or procedures must comply with the requirements specified in this SAP. Any deviation of a technical procedure or reference method must be noted within the appropriate logbook and, for laboratory analyses, in the Case Narrative of the analytical report.

Performance will be monitored in the field through the use of QC checks as previously discussed in Section 4.6. Performance will be monitored in the laboratory through the use of QC checks discussed in each laboratory QM and the PARCCS criteria presented in Tables 5 through 8.

As described in the guidance documents, assessment includes surveillance, peer review, management systems review, readiness review, technical systems audit, performance evaluation, data quality audit, and data quality assessment. The following assessment activities are planned:

- Peer review
- Technical systems audit
- Data quality assessment

5.1.1 Peer Review

Throughout the project, the ECs will maintain a system of peer review by which generated data can be checked and verified. Data that are transcribed and tabulated will be checked for accuracy and completeness.

5.1.2 Audits

The QA/QC audit is an independent systematic on-site review of facilities, equipment, training procedures, record keeping, data validation, data management, and reporting aspects of the field and laboratory QA/QC program. Audits may be performed on field operations and sampling procedures, laboratory analyses and documentation.

5.1.3 Field/Sampling Audit

ACL does not plan to conduct an audit of sampling activities. The field team leader will be responsible for following applicable quality assurance procedures described in this SAP.

5.1.4 Laboratory Audits

The laboratory will be expected to have a QA program whereby the QA department will routinely conduct internal audits. The laboratory QM discusses internal laboratory audits. ACL does not anticipate performing audits of the laboratory during this project. If an external audit is deemed necessary by the USEPA, then the USEPA will consult with ACL and the ECs regarding an appropriate approach.

5.1.5 Data Quality Assessment

Analytical data will be assessed through a series of evaluation procedures. The details regarding data evaluation and validation are discussed in Section 6. Data quality assessments will be performed as part of the semi-annual monitoring reports for the Site. These assessments will be included in and distributed to the parties that receive the semi-annual monitoring reports, including but not limited to the USEPA, DNREC, NCC and the ACPS.

5.2 Reports to Management

Timely quality assurance reports are necessary to the successful completion of this project. Quality assurance deficiencies in the field must be reported to the field team leader and the EC's QA and Project Manager. Quality assurance deficiencies in the laboratory must be reported in a timely manner to laboratory and project management personnel. The laboratory's policies and procedures for reporting quality assurance activities to management are included in each laboratory's QM and/or SOPs. Corrective actions for field and laboratory activities will be reported to the EC's QA and Project Manager, ACPS Chairman, and, if necessary, the USEPA Project Manager.

6.0 DATA VALIDATION AND USABILITY

6.1 Data Review, Verification, and Validation

The laboratory analytical data will be reviewed for completeness, QA/QC forms and holding times will be checked to ensure data quality. The data quality review will follow guidelines provided by USEPA Region III data validation guidance, which defers to the USEPA Contract Laboratory Program National Functional Guidelines for Superfund Organic and Inorganic Methods Data Review (USEPA, 2017)[6], and professional judgment, where necessary. Project-specific data quality objectives (DQOs) are presented in Section 3. The laboratory will perform data reduction in accordance with the individual analytical methodologies used for this project. The laboratory QMs or SOPs will have more detailed information regarding the laboratory data reduction procedures.

In general, data reduction of field measurements will not be necessary because readings will be recorded in field notebooks or field forms directly from the field instruments. If reduction of data is necessary because units of measurement are not comparable (e.g., Fahrenheit vs. Celsius), then these conversions will be performed in the office using standard spreadsheet software. Field measurements will be tabulated using spreadsheet or data base software. Field measurements are anticipated to be recorded as follows:

- DO is to be recorded to the nearest 0.01 mg/L
- pH is to be recorded to the nearest 0.01 std pH units
- Turbidity is to be recorded to the nearest 1 NTU
- ORP is to be recorded to the nearest 1 mV
- Specific conductance is to be recorded to the nearest 1 microsiemens/centimeter (uS/cm) or micromhos per centimeter (umhos/cm)
- Temperature is to be recorded to the nearest 0.1°C

6.2 Verification and Validation Methods

Data validation techniques include screening, accepting, rejecting or qualifying data on the basis of specific quality control criteria for holding times, blank results, spike results, surrogates, and field duplicates. Data validation is a process whereby erroneous data may be identified prior to entering the project record. Data Verification of field measurements will be performed by field personnel in consultation with the QA and Project Manager. Field personnel will verify the field data through review of calibration and duplicate data readings. The data will be reviewed to determine if there are anomalous readings. Anomalies will be resolved immediately by means such as re-calibration or re-acquisition of the measurement.

[6] Current USEPA National Functional Guidelines are shown. Data review will be performed in accordance with the most current versions of the guidance documents available at the time of data evaluation.

For field samples associated with this project that are sent to a laboratory, the laboratory will produce data packages that will contain the information needed for formal validation of the data. Data will undergo a data evaluation process by which accuracy, precision and completeness are assessed.

The data will be evaluated based upon holding times, blank results, and QC results assessing accuracy and precision. Analytical data packages will be reviewed for completeness and QC summaries will be evaluated. Data review required for this project will be performed under the direction of the QA Manager.

If, based upon this data review, the QA Manager believes that a more extensive data validation should be performed, then a subset of the data will undergo full data validation. Data validation will be performed using the guidelines cited in Section 6.1 and the specific analytical methodologies or SOPs. PARCCS, as defined in Section 3, will be evaluated based upon field sampling documentation, adherence to sample hold times, and analysis of QC samples. Qualifiers will be applied to the data using the logic specified in the validation guidelines cited in Section 6.1, as well as Tables 5 through 8.

Qualified results will be reported for validated samples on the analytical reporting forms provided in the data packages or as data summary tables accompanying the laboratory deliverable data package. Qualified results, data packages and analytical results will be stored electronically in the EC's project files and will also be entered into the project database.

The PARCCS criteria and criteria specified in applicable guidelines may not always be achievable. The data validation guidelines provide directions for the determination of data usability. Qualified data can often provide useful information, although the degree of certainty associated with the result may not be as planned. Professional judgment, in conjunction with appropriate guidance documents, will be used to determine data usability.

6.3 Reconciliation with User Requirements

Throughout the project, the ECs will determine if project DQOs are being met and assess whether the data that is being collected is sufficient and appropriate. Periodic evaluations of the sampling program will be made to determine if a change in frequency or analytical parameters is appropriate. Individuals making measurements throughout the process will also make assessments of whether the DQOs are being met.

Individuals making field measurements will determine whether or not field quality control criteria were met. The field QA/QC will be overseen by the field team leader. Corrective actions will be initiated in the field as necessary. This corrective action may include recalibration of instruments or use of a different type of instrument.

The analysts in the laboratory will determine if analytical QC criteria are achieved. Corrective action in the form of re-analysis or re-calibration may be warranted. Laboratory analytical data and field data will be

assessed by a data validation specialist under the direction of the QA Manager to determine usability with regard to the DQOs.

As noted in the data validation guidelines, data may not always meet precision and accuracy requirements but may still be considered usable. The data will be assessed with regard to the project DQOs, and professional judgment used in conjunction with guidance documents will determine data usability.

The ECs will assess collected data and ascertain whether objectives of the project are being met. The USEPA will be informed in writing of changes to the program that may be warranted.

7.0 ACRONYMS AND ABBREVIATIONS

%R	percent recovery
°C	degrees Celsius
1,2-DCA	1,2-dichloroethane
ACL	Army Creek Landfill
ACPS	Army Creek Private Settlors
APHA	American Public Health Association
AWC	Artesian Water Company
CFR	Code of Federal Regulations
COC	chain-of-custody
DI	de-ionized
DNREC	State of Delaware Department of Natural Resources and Environmental Control
DO	dissolved oxygen
DOT	Department of Transportation
DQOs	data quality objectives
EC	Environmental Consultant
EDD	electronic data deliverable
eV	electron volt
Fe	iron
FID	flame ionization detector
gal/ft	gallons per feet
GC/MS	gas chromatograph/mass spectrometer
GPR	ground-penetrating radar
HASP	Health and Safety Plan
HDPE	high-density polyethylene
IDW	investigation-derived waste
LC/MS/MS	Liquid Chromatography/Tandem Mass Spectrometry
LCS	laboratory control sample
MCAWW	Methods for Chemical Analysis of Water and Wastes
MDL	method detection limit
mg/L	milligrams per liter
ml/min	milliliters per minute
Mn	manganese
MPCU	Middle Potomac Confining Unit
MS	matrix spike
MSD	matrix spike duplicate
mV	millivolt
MW	monitoring well
NAD	North American Datum
NAPs	natural attenuation parameters
NCC	New Castle County
NGVD	National Geodetic Vertical Datum
NIST	National Institute of Standards and Technology
NTUs	Nephelometric Turbidity Units
OD	outer diameter
ORP	oxidation-reduction potential
PARCCS	Precision, Accuracy, Representativeness, Comparability, Completeness, and Sensitivity
PDF	portable document format
PFAS	per- and poly-fluoroalkyl substances
PFOA	perfluorooctanoic acid
PFOS	perfluorooctane sulfonate
PID	photoionization detector
PPE	personal protective equipment
ppm	parts per million

ppmv	parts per million by volume
PRT	post-run tubing
PVC	polyvinyl chloride
QA	Quality Assurance
QA/QC	Quality Assurance / Quality Control
QAPP	Quality Assurance Project Plan
QC	Quality Control
QL	quantitation limit
QM	Quality Manual
RPD	relative percent difference
SAP	Sampling and Analysis Plan
SOP	Standard Operating Procedures
SOW	Statement of Work
SRM	Standard Reference Material
TAL	Target Analyte List
umhos/cm	micromhos per centimeter
UPA	Upper Potomac Aquifer
UPCU	Upper Potomac Confining Unit
UPDC	Upper Potomac Dividing Clay
uS/cm	microSiemens per centimeter
USEPA	United States Environmental Protection Agency
UV	ultraviolet
VOCs	Volatile Organic Compounds

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TABLES

TABLE 1
DATA QUALITY OBJECTIVES
ADDITIONAL INVESTIGATION ACTIVITIES
ARMY CREEK LANDFILL SUPERFUND SITE
NEW CASTLE COUNTY, DELAWARE

Investigation Activity	Matrix	Number of Locations	Parameters of Interest	Frequency of Monitoring	Purpose/Objective of Activity
Groundwater Monitoring	Groundwater	3 existing wells and up to 6 new wells	Total and dissoved iron, manganese, and cobalt; TCL VOCs + up to 20 TICs; and field parameters (see note 3 below)	Quarterly for one year	Collect definitive data to define nature and extent of contamination
	Groundwater	3 existing wells and up to 6 new wells	Major cations and anions (see note 4 below)	Semi-annually in April and October for one year	Collect definitive data to define nature and extent of contamination and to evaluate cation/anion balance in groundwater
	Groundwater	13 existing wells and up to 6 new wells	PFAS	Once, coincident with annual Site-wide PFAS sampling (either April or October)	Collect definitive data to define nature and extent of contamination
Leachate	Leachate	Up to 10 existing gas vents	PFAS	Once, coincident with annual Site-wide PFAS sampling (either April or October)	Collect definitive data to define nature and extent of contamination
Surveying	NA	New well locations and existing well locations with survey discrepancies	Ground and top of PVC elevation (wells only), northings and eastings	Once, after installation of new wells	Collect definitive data to verify well elevations and provide location data for new well samples

Notes:

1. The Target Compound List (TCL) for VOCs is provided in Table 9.
2. The methodologies that will be used for analysis are listed in Table 10.
3. Field parameters for groundwater monitoring include: pH, temperature, specific conductivity, turbidity, dissolved oxygen, and oxidation-reduction potential.
4. Major cations and anions include: calcium, magnesium, potassium, sodium, ammonia, nitrate, nitrite, sulfate, sulfide, chloride, and bicarbonate.
5. VOCs, metals, and cations/anions quality control samples were collected per matrix at the following frequency: 1 field duplicate per twenty primary samples; 1 MS/MSD pair per twenty primary + field duplicate samples; 1 rinsate blank per day per type of decontamination event where non-dedicated equipment is used. 1 trip blank per day when aqueous VOC samples were collected.
6. PFAS quality control samples were collected per matrix at the following frequency: 1 field duplicate per twenty primary samples; 1 MS/MSD pair per twenty primary + field duplicate samples; 1 rinsate blank per day per type of decontamination event where non-dedicated equipment is used. 1 trip blank per day when aqueous PFAS samples were collected.
7. See Attachment F for acronyms and abbreviations

TABLE 2
DECISION THRESHOLD / ACTION LEVEL
ADDITIONAL INVESTIGATION ACTIVITIES
ARMY CREEK LANDFILL SUPERFUND SITE
NEW CASTLE COUNTY, DELAWARE

Investigation Activity - Goal	Matrix	Number of Locations	Parameters of Interest	Screening Values/Method	Decision Threshold / Action Level
Drilling - Collect qualitative data to assist in developing screen interval recommendations	Soil Groundwater	Up to 6 borings	Lithology; PID readings; visual and/or olfactory evidence of impacts	PID readings > 10 ppmv; visual evidence of a sheen or impacts; petroleum and/or chemical odor	1) If the screening values are met or exceeded, then a monitoring well will be screened across the 10-foot interval with the highest PID readings and/or the most visual and/or olfactory evidence of impacts within the unit to be monitored (i.e., UPA upper sand or UPA lower sand). 2) If the screening values are NOT met, then a monitoring well will be screened across the coarsest-grained 10-foot interval within the unit to be monitored (i.e., UPA upper sand or UPA lower sand).
Groundwater Monitoring - Collect definitive data to define nature and extent of contamination	Groundwater	5 existing wells and up to 6 new wells	Total and dissoved iron, manganese, and cobalt, and VOCs	MCLs, SMCLs and RSLs	1) If the screening values are exceeded, then additional investigation and/or plume stability evaluation may be necessary. 2) If the screening values are NOT exceeded but are above method detection limits, then quarterly monitoring should be reduced to semi-annual monitoring. 3) If the parameters are not detected at monitoring locations, then discontinuation of monitoring at those locations should be considered.
			Major cations and anions	Cation/Anion Balance	1) If the cation/anion balance exceeds 20% difference, then additional monitoirng of cations and anions and consideration of other potential cations and/or anions for analysis should be performed. 2)If the cation/anion balance has between 10 and 20% difference, then additional monitoring of cations and anions should be performed. 3) If the cation/anion balance has less than 10% difference, then additional monitoring of cations and anions should not be necessary.
	Groundwater	15 existing wells and up to 6 new wells	PFAS	HAL; RSL	1) If the screening values are exceeded, then additional evaluation may be necessary. 2) If the screening values are NOT exceeded but are above method detection limits, then annual monitoring should be considered. 3) If the parameters are not detected at monitoring locations, then PFAS monitoring at those locations should be discontinued.
Leachate - Collect definitive data to define nature and extent of contamination	Leachate	Up to 10 existing gas vents	PFAS	HAL; RSL	1) If the screening values are exceeded, then additional evaluation may be necessary. 2) If the screening values are NOT exceeded, then PFAS monitoring at those locations should be discontinued.

Notes:

1. The Target Compound List (TCL) for VOCs is provided in Table 9.
2. The methodologies that will be used for analysis are listed in Table 10.
3. Field parameters for groundwater monitoring include: pH, temperature, specific conductivity, turbidity, dissolved oxygen, and oxidation-reduction potential.
4. Major cations and anions include: calcium, magnesium, potassium, sodium, ammonia, nitrate, nitrite, sulfate, sulfide, chloride, and bicarbonate.
5. VOCs, metals, and cations/anions quality control samples were collected per matrix at the following frequency: 1 field duplicate per twenty primary samples; 1 MS/MSD pair per twenty primary + field duplicate samples; 1 rinsate blank per day per type of decontamination event where non-dedicated equipment is used. 1 trip blank per day when aqueous VOC samples were collected.
6. PFAS quality control samples were collected per matrix at the following frequency: 1 field duplicate per twenty primary samples; 1 MS/MSD pair per twenty primary + field duplicate samples; 1 rinsate blank per day per type of decontamination event where non-dedicated equipment is used. 1 trip blank per day when aqueous PFAS samples were collected.
7. See Attachment F for acronyms and abbreviations

TABLE 3
PROPOSED MONITORING PROGRAM
ADDITIONAL INVESTIGATION ACTIVITIES
ARMY CREEK LANDFILL SUPERFUND SITE
NEW CASTLE COUNTY, DELAWARE

Monitoring Location	Well Type	PFAS	Western Lobe	Supply Wells	Water Levels
MW-28	Former Recovery	X			X
MW-29	Former Recovery	X			X
MW-31	Former Recovery	X			X
RW-10	Former Recovery	X	X		X
BW-1	Existing Monitoring	X			X
BW-2	Existing Monitoring	X			X
BW-3	Existing Monitoring	X			X
MW-40	Existing Monitoring	X			X
MW-38N	Existing Monitoring				X
P-4	Existing Monitoring	X	X		X
P-4L	Proposed Monitoring	X	X		X
WL-1U	Proposed Monitoring	X	X		X
WL-1L	Proposed Monitoring	X	X		X
WL-2U	Proposed Monitoring	X	X		X
WL-2L	Proposed Monitoring	X	X		X
P-5U	Existing Monitoring				X
P-5L	Existing Monitoring				X
P-6	Existing Monitoring				X
MW-22N	Existing Monitoring	X	X		X
MW-22NU	Proposed Monitoring	X	X		X
MW-26N	Existing Monitoring				X
MW-49N	Existing Monitoring				X
MW-54	Existing Background	X			X
MW-56	Existing Background	X			X
MW-58	Existing Background	X			X
MW-18	Existing Monitoring				X
DGC-10S	Existing Monitoring				X
DGC-10D	Existing Monitoring				X
DGC-11S	Existing Monitoring				X
DGC-11D	Existing Monitoring				X
GV-1	Gas Vent	X			X
GV-7	Gas Vent	X			X
GV-9	Gas Vent	X			X
GV-13	Gas Vent	X			X
GV-14	Gas Vent	X			X
GV-17	Gas Vent	X			X
GV-29	Gas Vent	X			X
GV-46	Gas Vent	X			X
GV-48	Gas Vent	X			X
GV-51	Gas Vent	X			X
AWC-2	Supply Well			X	
AWC-G3R	Supply Well			X	
AWC-6R	Supply Well			X	
AWC-7	Supply Well			X	

3/27/2019

Notes:

X - Groundwater samples will be analyzed for PFAS suite, consistent with the PFAS suite for DS&G, plus field parameters.
Samples from gas vents will be analyzed for PFAS suite only

X - Quarterly analytical parameters will include VOCs, total and dissolved iron, total and dissolved manganese, total and dissolved cobalt, and field parameters. The semi-annual events (April and October) will also include and cations and anions as follows: calcium, magnesium, potassium, sodium, ammonia, nitrate, nitrite, sulfate, sulfide, chloride, and bicarbonate.

X - Supply wells will be sampled by AWC monthly for iron and manganese analyses, and quarterly for cobalt.
Addition of other parameters is under consideration by AWC. Only wells that are operating will be sampled during each event.

X - A complete round of water levels will be measured synoptically at all wells, within 48 hours of the completion of the sampling event.

(1) - PFAS monitoring event will be conducted synoptically during the first DS&G event performed after the new wells are installed.

(2) - Western Lobe Study will be conducted quarterly for four quarters, two of which will be done at same time as annual/semi-annual events.

(3) - Field Indicator Parameters include temperature, specific conductance, pH, oxidation-reduction potential, dissolved oxygen and turbidity.

(4) - See Attachment F for acronyms and abbreviations

TABLE 4
MONITORING POINT CONSTRUCTION INFORMATION
ADDITIONAL INVESTIGATION ACTIVITIES
ARMY CREEK LANDFILL SUPERFUND SITE
NEW CASTLE COUNTY, DELAWARE

Monitoring Point ID	Drilled Depth	Constructed Use	Inside Diameter (in)	Construction Material	Sounded Depth (ft-btoc)	TOC Elevation (ft-msl)	Screened Interval (ft-bgs)	Screen Length (ft)	Filter Pack Interval (ft-bgs)	Filter Pack Material	Backfill Interval[2] (ft-bgs)	Backfill Material	Filter Pack Length (ft)	Screened Unit	Surface Completion	Purging and Sampling Method	Proposed Sampling Depth (ft-btoc)	Secondary Method for Comparison	Previous Sampling Depth (ft-bgs)
MW-28	140	Former Extraction Well	6	Stainless Steel	111.6	20.37	43 - 120	77	No Record	No Record	120-130	No Record	≥77	UPA - Upper and Lower Sand	Standpipe	Submersible - low flow	50 and 90	yes - 3x purge	50
MW-29	130	Former Extraction Well	6	Stainless Steel	110.5	17.38	34 - 113	79	No Record	No Record	126-113	No Record	≥79	UPA - Upper and Lower Sand	Standpipe	Submersible - low flow	39 and 85	yes - 3x purge	39
MW-31	120	Former Extraction Well	6	Steel-PVC	112.1	13.77	59 - 116	57	No Record	No Record	116-120	No Record	≥57	UPA - Upper and Lower Sand	Standpipe	Submersible - low flow	75 and 95	yes - 3x purge	75
RW-10	102.5	Former Extraction Well	10	PVC	104	8.67	77 - 102	25	Unknown to 102.5	#2 Gravel	Not Applicable	Not Applicable	≥25.5	UPA - Upper Sand	Standpipe	Submersible - low flow	90	none	90
BW-1	126.5	Monitoring Well	4	PVC	132.9*	30.32*	116.2 - 136.2*	20	111.2-136.7*	#2 Morie Sand	Not Applicable	Not Applicable	25.5	UPA - Lower Sand	Standpipe	Submersible - low flow	126	none	126
BW-2	125	Monitoring Well	4	PVC	142.9*	33.68*	123 - 143*	20	118-143*	#2 Morie Sand	143-144*	Not Specified	≤26	UPA - Lower Sand	Standpipe	Submersible - low flow	133	none	133
BW-3	135	Monitoring Well	4	PVC	125	7.80	50 - 135	85	47-135	#2 Morie Sand	135-137	Not Specified	≤90	UPA - Upper and Lower Sand	Standpipe	Submersible - low flow	55 and 92	yes - 3x purge	92
MW-40	152	Monitoring Well	4	PVC	142.1	36.32	110 - 140	30	No Record	No Record	140-152	No Record	≥30	UPA - Lower Sand	Standpipe	Submersible - low flow	125	none	125
MW-38N	132	Monitoring Well	4	PVC	131.2	35.55	72 - 132	60	69-132	#2 Morie Sand	132-136	Not Specified	≤67	UPA - Upper and Lower Sand	Flush mount	NA - water levels only	NA	NA	NA
P-4	137	Monitoring Well	2	PVC	124.9	47.89	115 - 125	10	108-135	Sand	125-135	Sand	27	UPA - Upper Sand	Flush mount	Submersible - low flow	120	yes - 3x purge	120
P-4L	DNE	Monitoring Well (proposed)	2 (proposed)	PVC (proposed)	TBD	TBD	TBD	≤ 8 (proposed)	TBD	#2 Sand (proposed)	TBD	Grout (proposed)	≤10 (proposed)	UPA - Lower Sand (proposed)	Flush mount (proposed)	Submersible - low flow	TBD	NA	NA
WL-1U	DNE	Monitoring Well (proposed)	2 (proposed)	PVC (proposed)	TBD	TBD	TBD	≤ 8 (proposed)	TBD	#2 Sand (proposed)	TBD	Grout (proposed)	≤10 (proposed)	UPA - Upper Sand (proposed)	Standpipe (proposed)	Submersible - low flow	TBD	yes - 3x purge	NA
WL-1L	DNE	Monitoring Well (proposed)	2 (proposed)	PVC (proposed)	TBD	TBD	TBD	≤ 8 (proposed)	TBD	#2 Sand (proposed)	TBD	Grout (proposed)	≤10 (proposed)	UPA - Lower Sand (proposed)	Standpipe (proposed)	Submersible - low flow	TBD	yes - 3x purge	NA
WL-2U	DNE	Monitoring Well (proposed)	2 (proposed)	PVC (proposed)	TBD	TBD	TBD	≤ 8 (proposed)	TBD	#2 Sand (proposed)	TBD	Grout (proposed)	≤10 (proposed)	UPA - Upper Sand (proposed)	Standpipe (proposed)	Submersible - low flow	TBD	NA	NA
WL-2L	DNE	Monitoring Well (proposed)	2 (proposed)	PVC (proposed)	TBD	TBD	TBD	≤ 8 (proposed)	TBD	#2 Sand (proposed)	TBD	Grout (proposed)	≤10 (proposed)	UPA - Lower Sand (proposed)	Standpipe (proposed)	Submersible - low flow	TBD	NA	NA
P-5U	132	Monitoring Well	4	PVC	82.8	15.30	70 - 80	10	65-90	NR	90-132	NR	≥15	UPA - Upper Sand	Standpipe	NA - water levels only	NA	NA	NA
P-5L	180	Monitoring Well	4	PVC	138	14.90	126 - 136	10	104-126	NR	126-136	NR	≥22	UPA - Lower Sand	Standpipe	NA - water levels only	NA	NA	NA
P-6	117	Monitoring Well	4	PVC	110.5	43.06	100 - 110	10	87-120	NR	110-120	NR	33	UPA - Upper Sand	Flush mount	NA - water levels only	NA	NA	NA
MW-22N	159	Monitoring Well	4	PVC	159.18	51.58	139 - 159	20	134-159	#2 Morie Sand	Not Applicable	Not Applicable	25	UPA - Lower Sand	Flush mount	Submersible - low flow	149	yes - 3x purge	149
MW-22NU	DNE	Monitoring Well (proposed)	2 (proposed)	PVC (proposed)	TBD	TBD	TBD	≤ 8 (proposed)	TBD	#2 Sand (proposed)	TBD	Grout (proposed)	≤10 (proposed)	UPA - Upper Sand (proposed)	Flush mount (proposed)	Submersible - low flow	TBD	NA	NA
MW-26N	168	Monitoring Well	4	PVC	167.41	36.76	108 - 168	60	105-168	#2 Morie Sand	Not Applicable	Not Applicable	63	UPA - Upper and Lower Sand	Standpipe	NA - water levels only	NA	NA	NA
MW-49N	158	Monitoring Well	4	PVC	156.97	51.41	113 - 158	60	109-158	#2 Morie Sand	Not Applicable	Not Applicable	49	UPA - Upper and Lower Sand	Flush mount	NA - water levels only	NA	NA	NA
MW-54	131	Monitoring Well	4 (assumed)	PVC (assumed)	unknown	26.33	40 - 50	10	No Record	No Record	No Record	No Record	No Record	UPA - Upper Sand	Standpipe	Submersible - low flow	TBD - no log	none	NA
MW-56	105	Monitoring Well	4	PVC	unknown	23.21	75 - 100	25	No Record	No Record	100-105	No Record	≥25	UPA - Upper Sand	Standpipe	Submersible - low flow	85	none	NA
MW-58	118	Monitoring Well	4	PVC	unknown	10.62	65 - 110	35	No Record	No Record	110-118	No Record	≥35	UPA - Upper Sand	Standpipe	Submersible - low flow	75 and 95	yes - 3x purge	NA
MW-18	145	Monitoring Well	1	PVC	90.5	6.97	80 - 90	10	No Record	No Record	90-145	No Record	≥10	UPA - Upper Sand	Standpipe	NA - water levels only	NA	NA	NA
DGC-10S	115	Monitoring Well	4	PVC	115.4	41.92	93 - 113	20	91-113	#1 Morie Sand	113-115	Morie #1 Sand	24	UPA - Upper Sand	Standpipe	NA - water levels only	NA	NA	NA
DGC-10D	172	Monitoring Well	4	PVC	138.4	41.77	128 - 138	10	126-138	#1 Morie Sand	138-172	#1 Morie Sand/Sand fill and cuttings	46	UPA - Lower Sand	Standpipe	NA - water levels only	NA	NA	NA
DGC-11S	82	Monitoring Well	4	PVC	79.9	38.54	70 - 80	10	68-80	#1 Morie Sand	80-82	Morie #1 Sand	14	UPA - Upper Sand	Standpipe	NA - water levels only	NA	NA	NA
DGC-11D	182	Monitoring Well	4	PVC	115	38.93	105 - 115	10	103-115	#1 Morie Sand	115-182	#1 Morie Sand/Sand fill and cuttings	79	UPA - Upper Sand	Standpipe	NA - water levels only	NA	NA	NA
GV-1	unk	Former Gas Vent	4	PVC	23.59	30.96	unknown	unknown	unknown	unknown	unknown	unknown	unknown	Landfilled material	Standpipe	Bailer - 3x purge	NA	NA	NA
GV-7	unk	Former Gas Vent	4	PVC	27.3	35.13	unknown	unknown	unknown	unknown	unknown	unknown	unknown	Landfilled material	Standpipe	Bailer - 3x purge	NA	NA	NA
GV-9	unk	Former Gas Vent	4	PVC	19.94	33.83	unknown	unknown	unknown	unknown	unknown	unknown	unknown	Landfilled material	Standpipe	Bailer - 3x purge	NA	NA	NA
GV-13	unk	Former Gas Vent	4	PVC	22.3	37.64	unknown	unknown	unknown	unknown	unknown	unknown	unknown	Landfilled material	Standpipe	Bailer - 3x purge	NA	NA	NA
GV-14	unk	Former Gas Vent	4	PVC	25.77	39.77	unknown	unknown	unknown	unknown	unknown	unknown	unknown	Landfilled material	Standpipe	Bailer - 3x purge	NA	NA	NA
GV-17	unk	Former Gas Vent	4	PVC	23.8	38.61	unknown	unknown	unknown	unknown	unknown	unknown	unknown	Landfilled material	Standpipe	Bailer - 3x purge	NA	NA	NA
GV-29	unk	Former Gas Vent	4	PVC	24.65	36.22	unknown	unknown	unknown	unknown	unknown	unknown	unknown	Landfilled material	Standpipe	Bailer - 3x purge	NA	NA	NA
GV-46	unk	Former Gas Vent	4	PVC	25.77	38.27	unknown	unknown	unknown	unknown	unknown	unknown	unknown	Landfilled material	Standpipe	Bailer - 3x purge	NA	NA	NA
GV-48	unk	Former Gas Vent	4	PVC	31.9	38.93	unknown	unknown	unknown	unknown	unknown	unknown	unknown	Landfilled material	Standpipe	Bailer - 3x purge	NA	NA	NA
GV-51	unk	Former Gas Vent	4	PVC	29	36.70	unknown	unknown	unknown	unknown	unknown	unknown	unknown	Landfilled material	Standpipe	Bailer - 3x purge	NA	NA	NA

Notes:

1.) MW-22N, MW-26N and MW-49N sounded depth measurements collected on September 14, 2012 by Golder Associates; GV sounded depth measurements collected on September 27, 2004 by Rizzo Associates; all other sounded depth measurements collected February 29 through March 2, 2016 by Ruth Associates.
2.) ft-bgs = feet below ground surface
3.) ft-btoc = feet below top of casing
4.) ft-msl = feet mean sea level
5.) in = inches
6.) NA = not applicable
7.) PVC = polyvinyl chloride
8.) TBD = to be betermined
9.) TOC = top of casing
10.) UPA = Upper Potomac Aquifer
11.) "No Record" indicates monitoring well construction log was not found or was not created at the time of well installation.
12.) "Not Specified" indicates monitoring well construction log did not include the indicated information.
13.) unk = unknown
14.) * indicates different from monitoring well construction log due to extention of well by New Castle County in Reforestation Area
15.) See Attachment F for acronyms and abbreviations

TABLE 5
VOC ANALYSIS - GROUNDWATER MEASUREMENT PERFORMANCE CRITERIA
ARMY CREEK LANDFILL SUPERFUND SITE
NEW CASTLE COUNTY, DELAWARE

Matrix	Groundwater
Analytical Group	VOCs
Analytical Method	SW846 8260C
Analytical Organization	TestAmerica

QC Sample:	Frequency/ Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator	Measurement Performance Criteria
Method Blank	1 per extraction batch	No results above QL.	If sufficient sample volume is available, reanalyze the samples.	Laboratory Analyst	Accuracy	No results above QL.
Method Blank	1 per extraction batch	None.	Qualify data as required.	Data Validator	Accuracy	No results above QL.
Rinsate Blank	1 rinsate blank per 20 samples, whenever field decontaminated equipment is used.	None.	Qualify data as required.	Data Validator	Accuracy	No results above QL.
Trip Blank	1 trip blank each day VOC samples are collected.	None.	Qualify data as required.	Data Validator	Accuracy	No results above QL.
Field Duplicates	1 per 20 samples	None.	Qualify data as required.	Data Validator	Precision	<40% RPD
Surrogate Spike	Every sample	Meets method criteria.	If sufficient sample volume is available, reanalyze the samples.	Laboratory Analyst	Accuracy	Surrogate recovery meets QC limits as specified in the method.
Surrogate Spike	Every sample	Meets method criteria.	Qualify data as required.	Data Validator	Accuracy	Surrogate recovery meets QC limits as specified in the method.
MS	1 per 20 samples	See Table 12, when sample concentration is <4x the spike added.	When the recovery is outside of control limits and the sample result is < 4x the spike added, a post-digestion spike must be performed. An aliquot of the unspiked sample will be spiked at 2x the indigenous level or 2x the CRQL, whichever is greater.	Data Validator	Accuracy	See Table 12, when sample concentration is <4x the spike added.
MSD	1 per 20 samples	See Table 12, when sample concentration is <4x the spike added.	When the recovery is outside of control limits and the sample result is < 4x the spike added, a post-digestion spike must be performed. An aliquot of the unspiked sample will be spiked at 2x the indigenous level or 2x the CRQL, whichever is greater.	Data Validator	Accuracy	See Table 12, when sample concentration is <4x the spike added.
MS/MSD %R	1 per 20 samples	See Table 12	Qualify data as required.	Data Validator	Precision	See Table 12

Notes:
1. See Attachment F for acronyms and abbreviations

TABLE 6
INORGANICS ANALYSIS - GROUNDWATER MEASUREMENT PERFORMANCE CRITERIA
ARMY CREEK LANDFILL SUPERFUND SITE
NEW CASTLE COUNTY, DELAWARE

Matrix	Groundwater
Analytical Group	Inorganics
Analytical Method	SW-846 6010D / 6020A / 7470A
Analytical Organization	TestAmerica

QC Sample:	Frequency/ Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator	Measurement Performance Criteria
Rinsate Blank	1 rinsate blank per 20 samples, whenever field decontaminated equipment is used.	No results above IDL.	Qualify data as required.	Data Validator	Accuracy	No results above IDL.
ICP Interference Check Sample	1 at the beginning and end of each sample analysis run, or a minimum of twice per 8-hour shift, whichever is more frequent.	±20% of true value	Analysis terminated and affected samples reanalyzed.	Laboratory Analyst	Accuracy	±20% of true value
Initial Calibration Blank	Method specific	No results above IDL.	Qualify data as required.	Data Validator	Accuracy	No results above IDL.
Continuing Calibration Blank	1 per 10 samples	No results above IDL.	Reanalyze sample bracketed by compliant continuing calibration blank.	Data Validator	Accuracy	No results above IDL.
Preparation Blank	1 per extraction batch	No results above IDL.	Qualify data as required.	Data Validator	Accuracy	No results above IDL.
Field Duplicates	1 per 20 samples	none	Qualify data as required.	Data Validator	Precision	<40% RPD
MS	1 per 20 samples.	75-125% of true value, when sample concentration is <4x the spike added.	When the recovery is outside of control limits and the sample result is < 4x the spike added, a post-digestion spike must be performed. An aliquot of the unspiked sample will be spiked at 2x the indigenous level or 2x the CRQL, whichever is greater.	Data Validator	Accuracy	75-125% of true value, when sample concentration is <4x the spike added.
Post-Digestion spike	If warranted following MS analysis	75-125% of true value	Qualify data as required.	Data Validator	Accuracy	Minimum level of 10 times and a maximum of 100 times the lower limit of quantitation.
LCS	1 per 20 samples.	80-120% of true value.	Qualify data as required.	Data Validator	Accuracy	80-120% of true value.
Lab Duplicate	1 per 20 samples.	±20% of true value.	± CRDL when the sample value is < 5x CRDL, including when only one of the duplicate sample values is < 5x CRDL.	Data Validator	Accuracy	±20% of true value.
Initial Calibration Verification	Method specific	90-110% of true value for all analytes except mercury (90-120%) and cyanide (85-115%).	Qualify data as required.	Data Validator	Accuracy	90-110% of true value for all analytes except mercury (90-120%) and cyanide (85-115%).
Continuing Calibration Verification	1 per 10 samples	90-110% of true value for all analytes except mercury (90-120%) and cyanide (85-115%).	Reanalyze sample bracketed by compliant continuing calibration verification.	Data Validator	Accuracy	90-110% of true value for all analytes except mercury (90-120%) and cyanide (85-115%).
ICP Serial Dilution	When warranted.	When analyte concentration is minimally a factor of 50 above the IDL, an analysis of a 5-fold diltuion must agree within 10% difference of the original results.	Qualify data as required.	Data Validator	Precision	When analyte concentration is minimally a factor of 50 above the IDL, an analysis of a 5-fold diltuion must agree within 10% difference of the original results.

Notes:
1. See Attachment F for acronyms and abbreviations

TABLE 7
NATURAL ATTENUATION PARAMETERS - GROUNDWATER MEASUREMENT PERFORMANCE CRITERIA
ARMY CREEK LANDFILL SUPERFUND SITE
NEW CASTLE COUNTY, DELAWARE

Matrix	Groundwater
Analytical Group	Major Cations and Anions
Analytical Method	See Table 10
Analytical Organization	TestAmerica

QC Sample:	Frequency/ Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator	Measurement Performance Criteria
Method Blank	1 per extraction batch	No results above QL.	If sufficient sample volume is available, reanalyze the samples.	Laboratory Analyst	Accuracy	No results above QL.
Method Blank	1 per extraction batch	None.	Qualify data as required.	Data Validator	Accuracy	No results above QL.
Continuing Calibration Blank	1 per 10 samples	No results above QL.	Reanalyze sample bracketed by compliant Continuing Calibration Blank.	Laboratory Analyst	Accuracy	No results above QL.
Continuing Calibration Verification	1 per 10 samples	90-110% of true value	Reanalyze sample bracketed by compliant Continuing Calibration Verification.	Laboratory Analyst	Accuracy	90-110% of true value
Field Duplicates	1 per 20 samples	None.	Qualify data as required.	Data Validator	Precision	<40% RPD
LCS	1 per extraction batch	Meets laboratory QC limits in SOPs, Attachment D-2.	Analysis terminated and affected samples reanalyzed, if additional sample volume is available.	Laboratory Analyst	Accuracy	Meets laboratory QC limits in SOPs, Attachment D-2.
LCS	1 per extraction batch	Meets laboratory QC limits in SOPs, Attachment D-2.	Qualify data as required.	Data Validator	Accuracy	Meets laboratory QC limits in SOPs, Attachment D-2.
Matrix Spike	1 per 20 samples	Meets laboratory QC limits in SOPs, Attachment D-2.	If the LCS meets acceptance criteria, no corrective action is required. Otherwise, if sufficient sample volume is available, re-extract and reanalyze the samples.	Laboratory Analyst	Accuracy	Meets laboratory QC limits in SOPs, Attachment D-2.
Matrix Spike	1 per 20 samples	Meets laboratory QC limits in SOPs, Attachment D-2.	Qualify data as required.	Data Validator	Accuracy	Meets laboratory QC limits in SOPs, Attachment D-2.

Notes:
1. See Attachment F for acronyms and abbreviations

TABLE 8
PFAS - GROUNDWATER MEASUREMENT PERFORMANCE CRITERIA
ARMY CREEK LANDFILL SUPERFUND SITE
NEW CASTLE COUNTY, DELAWARE

Matrix	Groundwater
Analytical Group	Per- and Polyfluoroalkyl Substances (PFAS)
Analytical Method	EPA 537 Rev. 1.1, Modified
Analytical Organization	Eurofins

QC Sample:	Frequency/ Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator	Measurement Performance Criteria
Rinsate Blank	1 rinsate blank per 20 samples, whenever field decontaminated	None.	Qualify data as required.	Data Validator	Accuracy	No results above QL.
Trip Blank	1 trip blank each day PFAS samples are collected.	None.	Qualify data as required.	Data Validator	Accuracy	No results above QL.
Field Blank	1 field blank each day PFAS samples are collected.	None.	Qualify data as required.	Data Validator	Accuracy	No results above QL.
Method Blank	1 per extraction batch	No results above QL.	If sufficient sample volume is available, reanalyze the samples.	Laboratory Analyst	Accuracy	No results above QL.
Method Blank	1 per extraction batch	None.	Qualify data as required.	Data Validator	Accuracy	No results above QL.
Continuing Calibration Verification	1 per 10 samples	70-130% of true value	Reanalyze sample bracketed by compliant Continuing Calibration Verification.	Laboratory Analyst	Accuracy	70-130% of true value
Field Duplicates	1 per 20 samples	None.	Qualify data as required.	Data Validator	Precision	<40% RPD
Surrogate Spike	Every sample	Meets method criteria.	If sufficient sample volume is available, reanalyze the samples.	Laboratory Analyst	Accuracy	Surrogate recovery meets QC limits as specified in the method.
Surrogate Spike	Every sample	Meets method criteria.	Qualify data as required.	Data Validator	Accuracy	Surrogate recovery meets QC limits as specified in the method.
LCS	1 per extraction batch	Meets laboratory QC limits in SOPs, Attachment E-2.	Analysis terminated and affected samples reanalyzed, if additional sample volume is available.	Laboratory Analyst	Accuracy	Meets laboratory QC limits in SOPs, Attachment E-2.
LCS	1 per extraction batch	Meets laboratory QC limits in SOPs, Attachment E-2.	Qualify data as required.	Data Validator	Accuracy	Meets laboratory QC limits in SOPs, Attachment E-2.
Matrix Spike	1 per 20 samples	Meets laboratory QC limits in SOPs, Attachment E-2.	If the LCS meets acceptance criteria, no corrective action is required. Otherwise, if sufficient sample volume is available, re-extract and reanalyze the samples.	Laboratory Analyst	Accuracy	Meets laboratory QC limits in SOPs, Attachment E-2.
Matrix Spike	1 per 20 samples	Meets laboratory QC limits in SOPs, Attachment E-2.	Qualify data as required.	Data Validator	Accuracy	Meets laboratory QC limits in SOPs, Attachment E-2.
MS/MSD %R	1 per 20 samples	See Table 12	Qualify data as required.	Data Validator	Precision	See Table12

Notes:
1. See Attachment F for acronyms and abbreviations

TABLE 9
REFERENCE LIMITS - GROUNDWATER
ARMY CREEK LANDFILL SUPERFUND SITE
NEW CASTLE COUNTY, DELAWARE

Analytical Group	CAS	Analyte	Units	Achievable Laboratory Limits	
				MDLs	QLs
Inorganics	7429-90-5	Aluminum	ug/l	18.8	40
Inorganics	7440-36-0	Antimony	ug/l	0.399	2
Inorganics	7440-38-2	Arsenic	ug/l	0.734	2
Inorganics	7440-39-3	Barium	ug/l	1.16	4
Inorganics	7440-41-7	Beryllium	ug/l	0.245	0.8
Inorganics	7440-43-9	Cadmium	ug/l	0.808	2
Inorganics	7440-70-2	Calcium	ug/l	98.8	200
Inorganics	7440-47-3	Chromium	ug/l	2.3	4
Inorganics	7440-48-4	Cobalt	ug/l	1.6	4
Inorganics	7440-50-8	Copper	ug/l	1.99	4
Inorganics	7439-89-6	Iron	ug/l	51.1	120
Inorganics	7439-89-6	Iron - dissolved	ug/l	34.2	150
Inorganics	7439-92-1	Lead	ug/l	0.552	1.2
Inorganics	7439-95-4	Magnesium	ug/l	73.7	200
Inorganics	7439-96-5	Manganese	ug/l	2.88	8
Inorganics	7439-96-5	Manganese - dissolved	ug/l	0.987	15
Inorganics	7439-97-6	Mercury	ug/l	0.115	0.2
Inorganics	7440-02-0	Nickel	ug/l	2.36	4
Inorganics	7440-09-7	Potassium	ug/l	86.7	200
Inorganics	7782-49-2	Selenium	ug/l	5.35	10
Inorganics	7440-22-4	Silver	ug/l	0.591	2
Inorganics	7440-23-5	Sodium	ug/l	128	200
Inorganics	7440-28-0	Thallium	ug/l	0.157	0.8
Inorganics	7440-62-2	Vanadium	ug/l	1.11	4
Inorganics	7440-66-6	Zinc	ug/l	11.1	16
Cations/Anions	7664-41-7	Ammonia as N	mg/l	0.045	0.1
Cations/Anions	ALKB-C	Bicarbonate	mg/l	5	5
Cations/Anions	16887-00-6	Chloride	mg/l	0.078	0.12
Cations/Anions	Fe2+	Ferrous Iron	ug/l	120	400
Cations/Anions	14797-55-8-N	Nitrate as N	mg/l	0.0157	0.1
Cations/Anions	14797-65-0-N	Nitrite as N	mg/l	0.0191	0.12
Cations/Anions	14808-79-8	Sulfate as S04	mg/l	0.332	0.6
Cations/Anions	18496-25-8	Sulfide, total	mg/l	0.579	1
PFAS	2991-50-6	N-ethyl perfluorooctanesulfonamidoacetic acid (NEtFOSAA)	ng/l	1	3
PFAS	2355-31-9	N-methyl perfluorooctanesulfonamidoacetic acid (NMeFOSAA)	ng/l	1	3
PFAS	1763-23-1	Perfluorooctane sulfonate (PFOS)	ng/l	2	6
PFAS	375-73-5	Perfluorobutane sulfonate (PFBS)	ng/l	0.8	3
PFAS	335-76-2	Perfluorodecanoic acid (PFDA)	ng/l	0.5	2
PFAS	307-55-1	Perfluorododecanoic acid (PFDoA)	ng/l	0.5	2
PFAS	375-85-9	Perfluoroheptanoic acid (PFHpA)	ng/l	0.5	2
PFAS	355-46-4	Perfluorohexane sulfonate (PFHxS)	ng/l	1	3
PFAS	307-24-4	Perfluorohexanoic acid (PFHxA)	ng/l	0.6	2
PFAS	375-95-1	Perfluorononanoic acid (PFNA)	ng/l	0.6	2
PFAS	335-67-1	Perfluorooctanoic acid (PFOA)	ng/l	0.6	2
PFAS	376-06-7	Perfluorotetradecanoic acid (PFTA)	ng/l	0.5	2
PFAS	72629-94-8	Perfluorotridecanoic acid (PFTrDA)	ng/l	0.5	2
PFAS	2058-94-8	Perfluoroundecanoic acid (PFUnA)	ng/l	1	3
VOCs	71-55-6	1,1,1-Trichloroethane	ug/l	0.238	1
VOCs	79-34-5	1,1,2,2-Tetrachloroethane	ug/l	0.367	1
VOCs	79-00-5	1,1,2-Trichloroethane	ug/l	0.433	1
VOCs	75-34-3	1,1-Dichloroethane	ug/l	0.264	1
VOCs	75-35-4	1,1-Dichloroethene	ug/l	0.117	1
VOCs	526-73-8	1,2,3-Trimethylbenzene	ug/l	0.36	1
VOCs	95-63-6	1,2,4-Trimethylbenzene	ug/l	0.374	1
VOCs	107-06-2	1,2-Dichloroethane	ug/l	0.43	1
VOCs	78-87-5	1,2-Dichloropropane	ug/l	0.353	1
VOCs	108-67-8	1,3,5-Trimethylbenzene	ug/l	0.326	1

TABLE 9
REFERENCE LIMITS - GROUNDWATER
ARMY CREEK LANDFILL SUPERFUND SITE
NEW CASTLE COUNTY, DELAWARE

Analytical Group	CAS	Analyte	Units	Achievable Laboratory Limits	
				MDLs	QLs
VOCs	123-91-1	1,4-Dioxane	ug/l	0.2	0.4
VOCs	78-93-3	2-Butanone	ug/l	1.85	5
VOCs	591-78-6	2-Hexanone	ug/l	2.9	5
VOCs	108-10-1	4-Methyl-2-pentanone	ug/l	2.73	5
VOCs	67-64-1	Acetone	ug/l	4.98	5
VOCs	71-43-2	Benzene	ug/l	0.428	1
VOCs	75-27-4	Bromodichloromethane	ug/l	0.343	1
VOCs	75-25-2	Bromoform	ug/l	0.536	1
VOCs	74-83-9	Bromomethane	ug/l	1	1
VOCs	75-15-0	Carbon disulfide	ug/l	0.155	1
VOCs	56-23-5	Carbon tetrachloride	ug/l	0.208	1
VOCs	108-90-7	Chlorobenzene	ug/l	0.377	1
VOCs	75-00-3	Chloroethane	ug/l	0.32	1
VOCs	67-66-3	Chloroform	ug/l	0.326	1
VOCs	74-87-3	Chloromethane	ug/l	0.143	1
VOCs	156-59-2	cis-1,2-Dichloroethene	ug/l	0.219	1
VOCs	10061-01-5	cis-1,3-Dichloropropene	ug/l	0.455	1
VOCs	110-82-7	Cyclohexane	ug/l	0.321	1
VOCs	124-48-1	Dibromochloromethane	ug/l	0.281	1
VOCs	75-43-4	Dichlorofluoromethane	ug/l	0.341	1
VOCs	60-29-7	Ethyl ether	ug/l	0.439	1
VOCs	100-41-4	Ethylbenzene	ug/l	0.298	1
VOCs	496-11-7	Indane	ug/l	0.345	1
VOCs	98-82-8	Isopropylbenzene	ug/l	0.336	1
VOCs	108-87-2	Methylcyclohexane	ug/l	0.258	1
VOCs	75-09-2	Methylene Chloride	ug/l	0.315	1
VOCs	1634-04-4	MTBE	ug/l	0.465	1
VOCs	103-65-1	N-Propylbenzene	ug/l	0.322	1
VOCs	100-42-5	Styrene	ug/l	0.415	1
VOCs	127-18-4	Tetrachloroethene	ug/l	0.249	1
VOCs	109-99-9	Tetrahydrofuran	ug/l	1.04	2
VOCs	108-88-3	Toluene	ug/l	0.379	1
VOCs	156-60-5	trans-1,2-Dichloroethene	ug/l	0.235	1
VOCs	10061-02-6	trans-1,3-Dichloropropene	ug/l	0.485	1
VOCs	79-01-6	Trichloroethene	ug/l	0.314	1
VOCs	75-01-4	Vinyl chloride	ug/l	0.171	1
VOCs	1330-20-7	Xylenes, Total	ug/l	0.654	2

Notes:
1) MDLs and QLs were based on QC limits as of October 21, 2010 and updated January 24, 2018 for analysis of samples following the various analytical methods as listed in Table 10. TestAmerica Edison and Eurofins routinely re-evaluate QC criteria using the procedures in the laboratory QMs (see Attachments D-1 and E-1, respectively).
2) See Attachment F for acronyms and abbreviations

TABLE 10
ANALYTICAL REQUIREMENTS
ARMY CREEK LANDFILL SUPERFUND SITE
NEW CASTLE COUNTY, DELAWARE

PARAMETER	ANALYTICAL AND PREPARATION SOP REFERENCE[1]	METHODOLOGY	CONTAINER	MINIMUM SAMPLE VOLUME REQUIRED	PRESERVATION	FIELD FILTERED	HOLD TIME [2]
Groundwater							
Ammonia	ED-WET-018	SM 4500 NH_3 H	1-500 ml polyethylene	500 ml	Cool $\leq 6^\circ$ C, H_2SO_4; pH<2	No	28 days
Bicarbonate	ED-WET-039	SM2320B	1-100 ml polyethylene	100 ml	Cool $\leq 6^\circ$ C	No	14 days
Chloride	ED-GCS-022	EPA 300.0	1-250 ml polyethylene	200 ml	Cool $\leq 6^\circ$ C	No	28 days
Ferrous Iron	ED-WET-057	SM 3500 FE D	1-125 ml polyethylene	50 ml	Cool $<6^\circ$ C; HCl, pH<2	No	ASAP
TAL Metals (dissolved)	ED-MTP-003, ED-MT-004	SW-846 6010D	1-500 ml polyethylene	300 ml	Cool $\leq 6^\circ$ C; HNO_3, pH<2 after filter	Yes	180 days
TAL/RCRA[4] Metals	ED-MTP-003, ED-MT-017, ED-MT-029	SW-846 6020A/7470A	1-500 ml polyethylene	300 ml	Cool $\leq 6^\circ$ C; HNO_3, pH<2	No	180 days
Nitrate	ED-GCS-022	EPA 300.0	1-100 ml polyethylene	100 ml	Cool $\leq 6^\circ$ C	No	48 hours
Nitrite	ED-GCS-022	EPA 300.0	1-100 ml polyethylene	100 ml	Cool $\leq 6^\circ$ C	No	48 hours
PFAS	1-P-QM-WI-9039651	EPA 537 Rev 1.1, Modified	1-100 ml PFAS-free polyethylene; Teflon-free lids	100 ml	Cool $\leq 6^\circ$ C	No	14 days (extraction); 28 days (analysis)
Sulfate	ED-GCS-022	EPA 300.0	1-100 ml polyethylene	100 ml	Cool $\leq 6^\circ$ C	No	28 days
Sulfide	ED-WET-069	SM 4500 S2 E	1-500 ml polyethylene	500 ml	Cool $<6^\circ$ C; ZnAc/NaOH, pH>9	No	7 days
VOCs + 10 TICs	ED-MSV-001, ED-MSV-014	SW-846 8260C / SIM	3-40 ml glass vial	3-40 ml	Cool $\leq 6^\circ$ C; HCl, pH<2	No	14 days

Notes:
1. Reference number from Table 11.
2. Hold time based upon day of sample collection not Verified Time of Sample Receipt.
3. RCRA 8 Metals list includes: arsenic, barium, cadmium, chromium, lead, mercury, silver, selenium
4. The total metals holding time is 28 days for mercury, 180 days for all other metals.
5. The aqueous SVOC holding time is 7 days for extraction, 40 days from extraction to analysis.
6. The frequency of temperature blanks for cooler temperature verification during shipment is one blank per cooler.
7. See Attachment F for acronyms and abbreviations

TABLE 11
ANALYTICAL SOP REFERENCES
ARMY CREEK LANDFILL SUPERFUND SITE
NEW CASTLE COUNTY, DELAWARE

Reference Number	Title, Revision Date, and/or Number	Analytical Group
ED-MT-004	Trace Metals Analysis by Inductively Coupled Plasma Emission Spectroscopy by SW846 Method 6010B, 6010C & 6010D	Inorganics
ED-MSV-014	SW846 Method 8260C, Volatile Organic Compounds by Gas Chromatography/Mass Spectrometry (GC/MS)	VOCs
1-P-QM-WI-9039651	Determination of Selected Perfluorinated Alkyl Acids in Drinking Water by Solid Phase Extraction and LC/MS/MS, Revision 1.1, 9/2009	PFAS
ED-GCS-022	Anions by Ion Chromatography using EPA Method 300.0, SW846 9056A and SM 4110 B	Major Cations and Anions
ED-MSV-001	Purge and Trap for Aqueous Samples, SW846 Method 5030B and 5030C	VOCs
ED-MT-029	Trace Metals Analysis for Water, Wastewater, Soil, Sediment and Leachate Samples by ICP-MS Method No(s). EPA Method 200.8 and SW-846 Method 6020	Inorganics
ED-MTP-003	Digestion of Water and Wastewater Samples for Analysis by ICP and ICP-MS, SW846 Method 3010A	Inorganics
ED-WET-018	Analysis of Ammonia in Water, Wastewater and Soil-Automated by Methods EPA 350.1, SM 4500-NH3 B plus G-11, SM 4500-NH3 B plus H-11, and QuikChem Method 10-107-06-1-C rev. 05-07-87	Major Cations and Anions
ED-WET-039	Analysis of Alkalinity in Water, Wastewater and Soil by Manual Titration or Auto-Titrator, Standard Method 2320 B-11	Major Cations and Anions
ED-WET-057	Analysis of Ferrous Iron in Aqueous Samples by Standard Methods 3500- Fe D - Discreet Analyzer	Major Cations and Anions
ED-WET-069	Analysis of Sulfide in Water, Titrimetric by Standard Methods 4500-S2 F and SW846 9034	Major Cations and Anions

Notes:
1) See Attachment F for acronyms and abbreviations

TABLE 12
MS/MSD DATA SUMMARY REQUIREMENTS
ARMY CREEK LANDFILL SUPERFUND SITE
NEW CASTLE COUNTY, DELAWARE

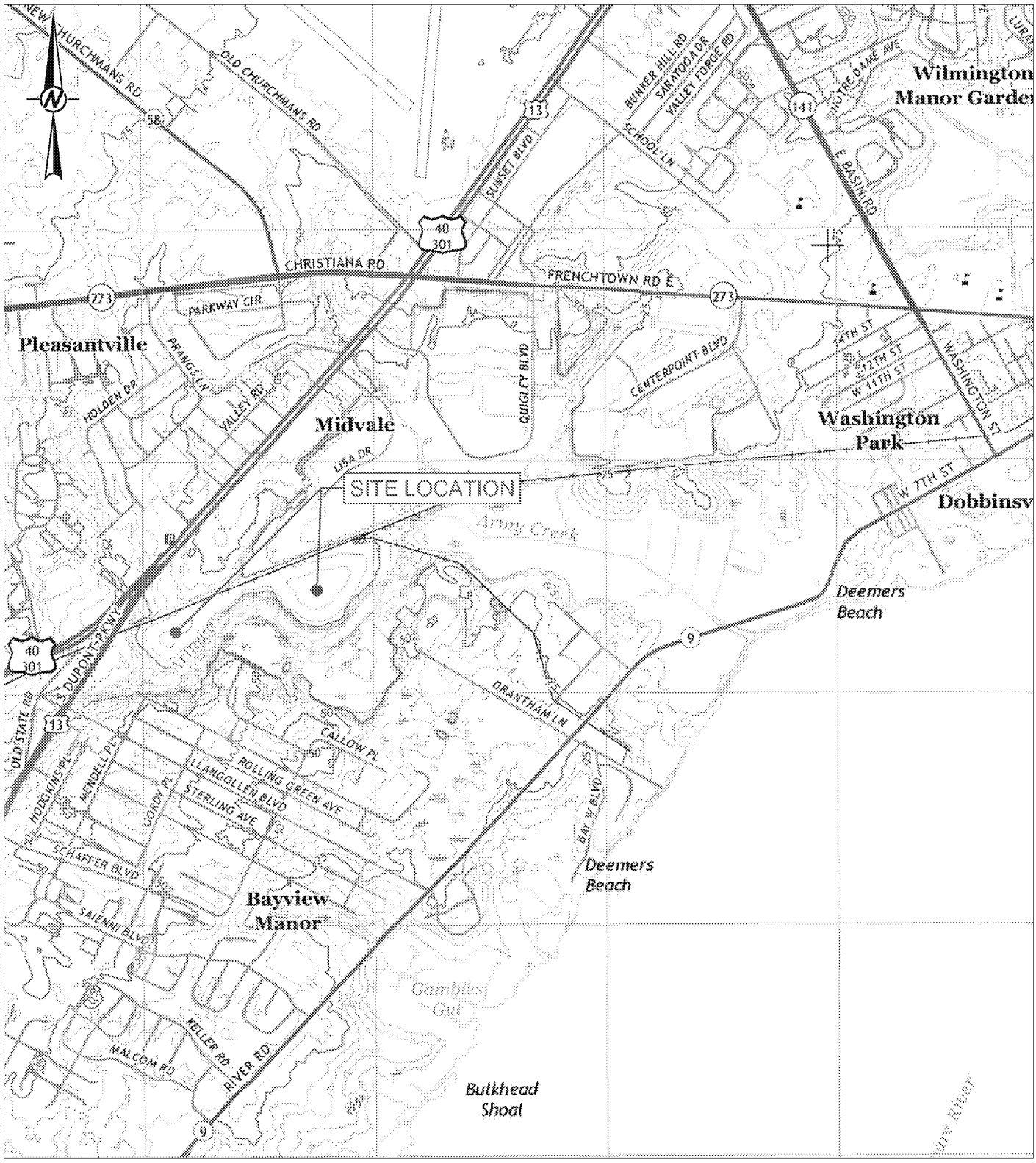
Compound	MS/MSD % R	MS/MSD RPD
Inorganic Aqueous Samples		
Aluminum	70-130	--
Antimony	70-130	--
Arsenic	70-130	--
Barium	70-130	--
Beryllium	70-130	--
Cadmium	70-130	--
Calcium	70-130	--
Chromium	70-130	--
Cobalt	70-130	--
Copper	70-130	--
Iron	70-130	--
Iron - dissolved	70-130	--
Lead	70-130	--
Magnesium	70-130	--
Manganese	70-130	--
Manganese - dissolved	70-130	--
Mercury	70-130	--
Nickel	70-130	--
Potassium	70-130	--
Selenium	70-130	--
Silver	70-130	--
Sodium	70-130	--
Thallium	70-130	--
Vanadium	70-130	--
Zinc	70-130	--
Cation/Anion Aqueous Samples		
Ammonia as N	65-135	--
Bicarbonate	85-115	--
Chloride	90-110	--
Ferrous Iron	90-110	--
Nitrate as N	90-110	--
Nitrite as N	90-110	--
Sulfate as S04	90-110	--
Sulfide, total	90-110	--
PFAS Aqueous Samples		
N-ethyl perfluorooctanesulfonamidoacetic acid (NEtFOSAA)	70-130	30
N-methyl perfluorooctanesulfonamidoacetic acid (NMeFOSAA)	70-130	30
Perfluorooctane sulfonate (PFOS)	70-130	30
Perfluorobutane sulfonate (PFBS)	70-130	30
Perfluorodecanoic acid (PFDA)	70-130	30
Perfluorododecanoic acid (PFDoA)	70-130	30
Perfluoroheptanoic acid (PFHpA)	70-130	30
Perfluorohexane sulfonate (PFHxS)	70-130	30
Perfluorohexanoic acid (PFHxA)	70-130	30
Perfluorononanoic acid (PFNA)	70-130	30
Perfluorooctanoic acid (PFOA)	70-130	30
Perfluorotetradecanoic acid (PFTA)	70-130	30
Perfluorotridecanoic acid (PFTrDA)	70-130	30
Perfluoroundecanoic acid (PFUnA)	70-130	30

TABLE 12
MS/MSD DATA SUMMARY REQUIREMENTS
ARMY CREEK LANDFILL SUPERFUND SITE
NEW CASTLE COUNTY, DELAWARE

VOC Aqueous Samples		
1,1,1-Trichloroethane	75-125	30
1,1,2,2-Tetrachloroethane	74-120	30
1,1,2-Trichloroethane	78-120	30
1,1-Dichloroethane	77-123	30
1,1-Dichloroethene	74-123	30
1,2,3-Trimethylbenzene	70-130	30
1,2,4-Trimethylbenzene	78-122	30
1,2-Dichloroethane	76-121	30
1,2-Dichloropropane	77-123	30
1,3,5-Trimethylbenzene	80-120	30
1,4-Dioxane	10-150	30
2-Butanone	64-120	30
2-Hexanone	71-125	30
4-Methyl-2-pentanone	78-124	30
Acetone	39-150	30
Benzene	77-121	30
Bromodichloromethane	76-120	30
Bromoform	53-120	30
Bromomethane	10-150	30
Carbon disulfide	69-133	30
Carbon tetrachloride	70-132	30
Chlorobenzene	80-120	30
Chloroethane	52-150	30
Chloroform	80-120	30
Chloromethane	56-131	30
cis-1,2-Dichloroethene	80-120	30
cis-1,3-Dichloropropene	77-120	30
Cyclohexane	56-150	30
Dibromochloromethane	73-120	30
Dichlorofluoromethane	71-145	30
Ethyl ether	68-136	30
Ethylbenzene	80-120	30
Indane	80-120	30
Isopropylbenzene	80-123	30
Methylcyclohexane	61-145	30
Methylene Chloride	77-123	30
MTBE	79-122	30
N-Propylbenzene	80-123	30
Styrene	80-120	30
Tetrachloroethene	78-122	30
Tetrahydrofuran	79-122	30
Toluene	80-120	30
trans-1,2-Dichloroethene	79-120	30
trans-1,3-Dichloropropene	76-120	30
Trichloroethene	77-120	30
Vinyl chloride	62-138	30
Xylenes, Total	80-120	30

Notes:
1) See Attachment F for acronyms and abbreviations

FIGURES



REFERENCE(S)

1. BASE MAP TAKEN FROM USGS 7.5 MINUTE QUADRANGLE OF WILMINGTON SOUTH, DELAWARE, DATED 2016.

0 1000 2000
1" = 2000' FEET

CLIENT
ARMY CREEK LANDFILL SUPERFUND SITE
NEW CASTLE, DELAWARE

PROJECT
ADDITIONAL INVESTIGATION WORK PLAN

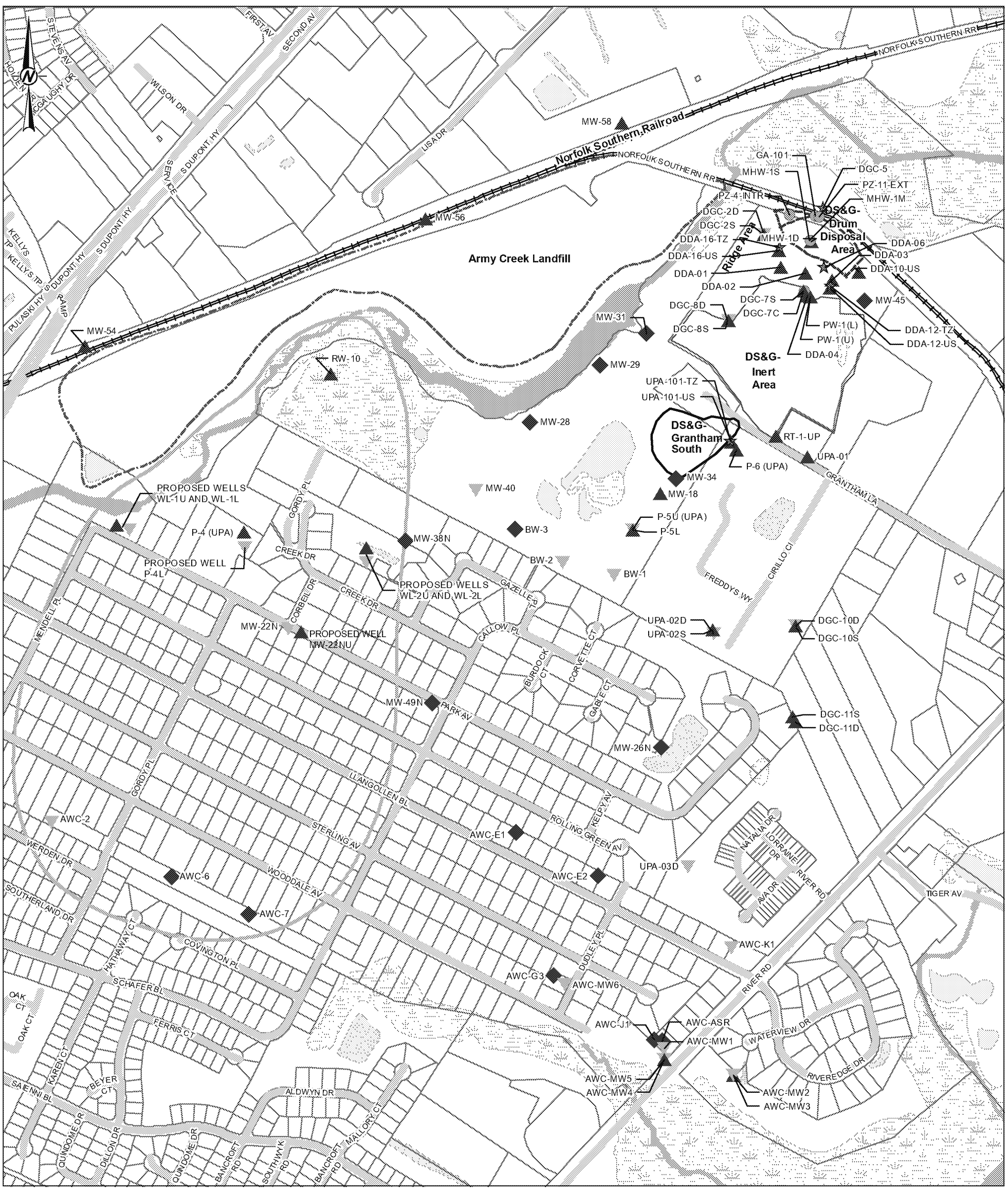
CONSULTANT

GOLDER

YYYY-MM-DD	2019-03-25
DESIGNED	BAR
PREPARED	AM
REVIEWED	BAR
APPROVED	TAM

TITLE
SITE LOCATION MAP

PROJECT NO	CONTROL	REV.	FIGURE
1899295	0001-005	0	1



LEGEND

- WELL SCREENED IN UPCU TRANSITION ZONE
- WELL SCREENED IN UPA UPPER SAND
- WELL SCREENED IN UPA LOWER SAND
- WELL SCREENED ACROSS UPA UPPER SAND AND LOWER SAND
- WELL SCREENED IN COLUMBIA AQUIFER
- WESTERN LOBE STUDY BOUNDARY

REFERENCE(S)

1. BASE DATA FROM NEW CASTLE COUNTY DELAWARE, DEPARTMENT OF LAND USE, "EPARCEL VIEW MAP" WEB SITE GIS DATA DOWNLOAD. DATA ACQUIRED 01/18/2012.

0 600 1,200
1" = 600 feet Feet

CLIENT
ARMY CREEK LANDFILL SUPERFUND SITE
NEW CASTLE, DELAWARE

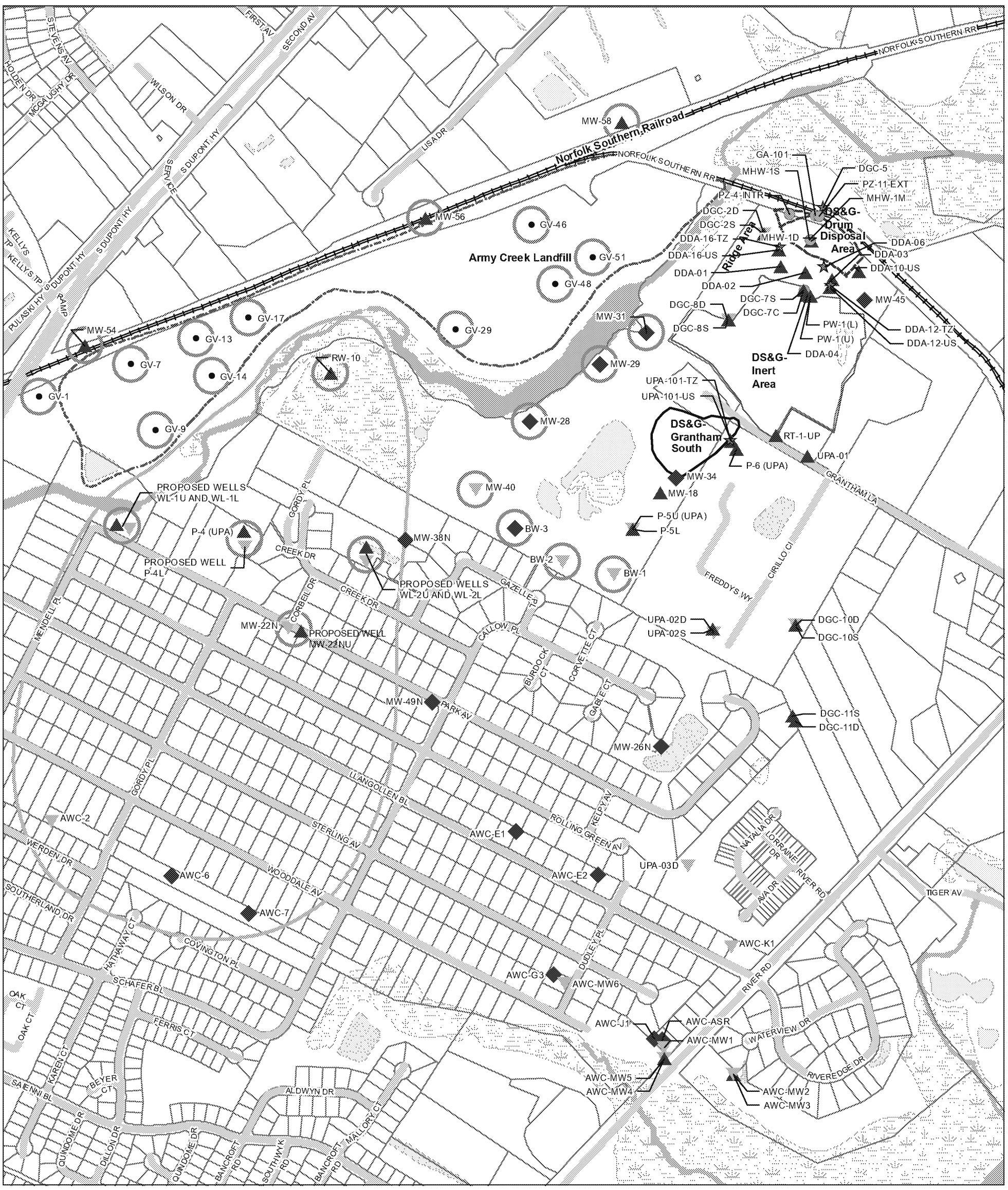
PROJECT
ADDITIONAL INVESTIGATION WORK PLAN

CONSULTANT
GOLDER

YYYY-MM-DD	2019-03-25
DESIGNED	BAR
PREPARED	AM
REVIEWED	BAR
APPROVED	TAM

TITLE
EXISTING AND PROPOSED MONITORING NETWORK FOR ACL WESTERN LOBE INVESTIGATION

PROJECT NO.	CONTROL	REV.	FIGURE
1899295	0001-004	0	2



LEGEND

- GV
- WELL SCREENED IN UPCU TRANSITION ZONE
- WELL SCREENED IN UPA UPPER SAND
- WELL SCREENED IN UPA LOWER SAND
- WELL SCREENED ACROSS UPA UPPER SAND AND LOWER SAND
- WELL SCREENED IN COLUMBIA AQUIFER
- WESTERN LOBE STUDY BOUNDARY
- PFAS SAMPLING LOCATION

REFERENCE(S)

1. BASE DATA FROM NEW CASTLE COUNTY DELAWARE, DEPARTMENT OF LAND USE, "EPARCEL VIEW MAP" WEB SITE GIS DATA DOWNLOAD. DATA ACQUIRED 01/18/2012.

CLIENT
ARMY CREEK LANDFILL SUPERFUND SITE
NEW CASTLE, DELAWARE

PROJECT
ADDITIONAL INVESTIGATION WORK PLAN

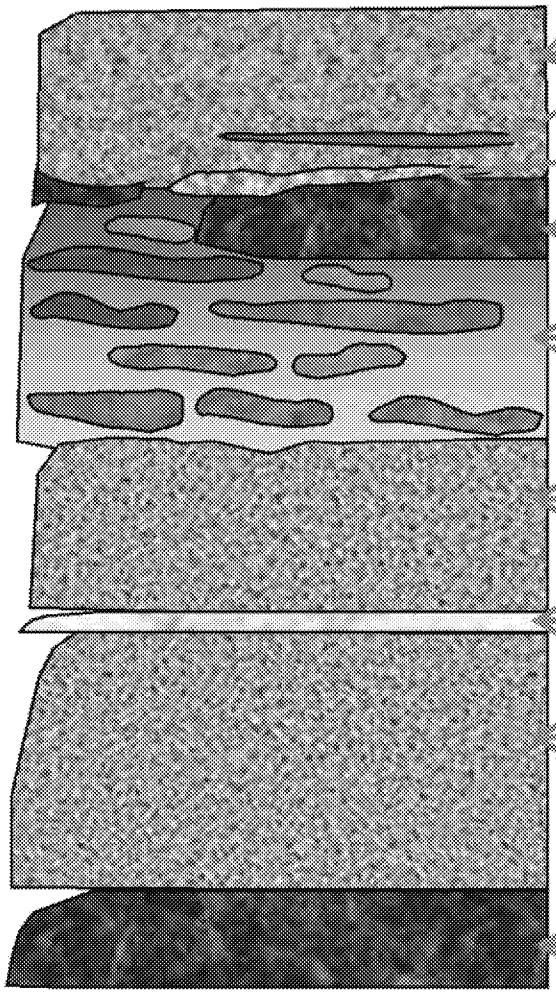
CONSULTANT
GOLDER

YYYY-MM-DD	2019-03-25
DESIGNED	BAR
PREPARED	AM
REVIEWED	BAR
APPROVED	TAM

TITLE
PROPOSED PFAS GROUNDWATER SAMPLING LOCATIONS

PROJECT NO.	CONTROL	REV.	FIGURE
1899295	0001-007	0	3

Conceptual Site Model Lithologic Diagram



Columbia Sand – brown, tan, orange sandy aquifer unit.

Columbia Clay (not always present) – brown, tan clay unit located within the Columbia Sand.

Basal Gravel (not always present) – gravel and cobble unit with coarse sand.

Upper Potomac Confining Unit (UPCU) (not always present) – hard, competent, dry, mottled red-orange-yellow-white clay unit. Eroded in some areas by basal gravel (paleochannel).

UPCU Transition Zone (UPCUTZ) (not always present) - interbedded silt, clay, and sand, but generally fining upward sequence.

Upper Potomac Aquifer (UPA) – Upper Sand – generally a fine to medium sand unit in the Site area.

Upper Potomac Dividing Clay (UPDC) – Typically, a mottled clay unit, generally present in the Site area, but can be thin or interbedded with sand.

Upper Potomac Aquifer (UPA) – Lower Sand – generally a fine to coarse sand unit greater than 10 feet thick in the Site area.

Middle Potomac Confining Unit (MPCU) - competent, grey or mottled red-orange-yellow-white clay unit.

NOT TO SCALE

CLIENT ARMY CREEK LANDFILL SUPERFUND SITE NEW CASTLE, DELAWARE	PROJECT ADDITIONAL INVESTIGATION WORK PLAN
CONSULTANT GOLDER	TITLE **CONCEPTUAL STRATIGRAPHIC COLUMN**

YYYY-MM-DD	2019-03-25
DESIGNED	BAR
PREPARED	AM
REVIEWED	BAR
APPROVED	TAM

PROJECT NO	CONTROL	REV.	FIGURE
1899295	0001-006	0	4

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI A

ATTACHMENT A

STANDARD OPERATING PROCEDURES (SOPS) FOR PFAS SAMPLING EVENT

Title: General Field Methods for PFAS Sampling Programs

1.0 GENERAL APPLICABILITY

The purpose of this Standard Operating Procedure (SOP) is to describe the procedures that shall be used during implementation of this per- and polyfluoroalkyl substances (PFAS) sampling program.

Due to the extremely low method detection limits associated with PFAS analysis (i.e., nanograms per liter [ng/l]) and the many potential sources of trace levels of PFAS, field personnel shall employ the greatest caution by strictly following the protocols described herein. Frequent replacement of nitrile gloves and decontamination of non-dedicated sampling equipment in accordance with the appropriate procedures will reduce the potential for false detections of PFAS.

This SOP includes the following:

- Considerations regarding food packaging and food consumption during PFAS sampling programs
- Field gear and clothing restrictions
- Personal hygiene requirements
- Sample area access restrictions
- Field equipment decontamination

Some of the provisions of the PFAS sampling program requirements described herein may conflict with standard health and safety procedures (e.g., use of insect repellant or sunscreen). Therefore, prior to implementation of a field program subject to these General Provisions, an Addendum to the site-specific Health and Safety Plan (HASP) shall be prepared to address any potential conflicts between the requirements described herein and standard health and safety procedures.

2.0 RESPONSIBILITIES

The Field Team Leader and field personnel have the shared responsibility to oversee and ensure that the PFAS sampling program is performed in accordance with the program-specific protocols described in this SOP. The Field Team Leader shall ensure that on-site personnel, including subcontractors and third parties that may have direct access to the sampling area, understand and comply with this SOP. Field personnel shall be notified of these requirements a minimum of three days prior to the start of field work in order to have the time to appropriately comply with many of the food and clothing requirements prior to arriving at the site.

3.0 GENERAL FIELD METHODS

3.1 Food Consumption

Components of some food packages have been treated to resist wetting. Historically, this is achieved through the use of PFAS. Accordingly, field personnel shall avoid the use of paper bags and other paper packaging to transport food to the site, including pre-wrapped foods and snacks (e.g., chocolate bars, energy bars, granola bars, potato chips, etc.). Field personnel shall not bring any fast food to the site that uses any form of paper wrapping such as sandwiches or paper drinking cups. If possible, field personnel shall use hard plastic or stainless steel food containers. Field personnel shall not use aluminum foil, wax paper, or coated textiles to transport food to the site.

The Teflon® coating on some frying pans contains fluorinated compounds and as such represents a potential source of PFAS. Field personnel shall not transport to or consume food at the site that has been prepared using a Teflon® coated cooking utensil.

Field personnel shall not consume food or beverages in the field vehicle or in the immediate vicinity of the sample location. Prior to consuming food or beverages, field personnel shall remove their nitrile gloves and coveralls and move to a location a minimum distance of 35 feet away from the sample location, preferably in the downwind direction. When finished eating or drinking, field personnel shall wash their hands, put their coveralls back on and put on a new pair of nitrile gloves prior to returning to the work area.

3.2 Field Gear and Clothing Restrictions

Because treatments to provide water resistant, water proof, or stain-resistant clothing include the use of PFAS, field personnel shall not wear any water resistant, water proof, stain-resistant treated clothing or Tyvek clothing during the field program. Permissible field clothing for PFAS sampling programs includes clothing made from natural fibers, preferably cotton. Clothing made of synthetic fibers shall be avoided (i.e., reflective vests).

Field clothing shall be laundered with a minimal amount of detergent and no fabric softener or scented products shall be used. Once field clothing has been washed appropriately, field clothing shall be washed a second time on a rinse-only cycle, using only water, prior to drying. Anti-static dryer sheets shall not be used when drying field clothing. Field clothing shall preferably be old cotton clothing that has been laundered many times, as new clothing may contain PFAS related treatments. Clothing containing Gore-Tex™ shall not be worn during the sampling program, as Gore-Tex™ clothing contains a PFAS membrane.

Waterproof field books shall not be used; field notes shall be recorded on loose paper using aluminum clip boards. Plastic clip boards, self-sticking notes, binders or spiral hard cover notebooks shall not be used. Field notes shall be recorded in pen or pencil. Markers shall not be used.

Most safety footwear is constructed of leather and synthetic materials that have been treated to provide some degree of waterproofing and/or increased durability. Therefore, footwear materials represent a potential source of trace PFAS. Field personnel contact with safety footwear including donning footwear or tying laces shall not occur within 35-feet of the sampling area. If footwear must be adjusted, field personnel shall re-locate to an area a minimum of 35-feet from the sampling area, preferably in a downwind direction, and make the necessary adjustments. Nitrile gloves shall be worn when contacting footwear. The nitrile gloves worn while contacting footwear shall be removed and new nitrile gloves shall be put on prior to re-entering the sampling area.

Disposable nitrile gloves shall be worn at all times. A new pair of nitrile gloves shall be donned prior to the following activities at each sample location:

- Contact with laboratory-suppled sample containers or PFAS-free water containers
- Decontamination of sampling equipment
- Insertion of anything into the well (e.g., HDPE tubing, HydraSleeve, bailer, etc.)
- Insertion of silicon tubing into the peristaltic pump

- Completion of monitoring well purging
- Sample collection
- Handling of QA/QC samples including field blanks and equipment blanks
- After the handling of any non-dedicated sampling equipment or contact with non-decontaminated surfaces

Because field vehicle seats may have been treated with PFAS-containing products for stain resistance, the seats of field vehicles shall be covered with a well laundered cotton sheet or blanket for the duration of the field program in order to avoid direct contact between field personnel clothing and vehicle seat fabric. Measures taken to mitigate field personnel contact with field vehicle seat fabric shall not in any way interfere with the functionality or impede the use of vehicle safety belts.

3.3 Personal Hygiene

Field personnel shall not use shampoo, conditioner, body gel, cosmetic cream, or hand cream as part of their personal showering routine on the day of a sampling event, as these products may contain surfactants and represent a potential source of PFAS. Field personnel shall follow their normal hygiene routine the night before a sampling event and then rinse with water only the morning before a sampling event. The use of bar soap is acceptable; however, bar soap including moisturizers shall be avoided.

Field personnel shall not use moisturizers, cosmetics, dental floss, sunscreen, and/or insect repellent for the duration of the field program, either on-site or off-site, as these products may contain trace PFAS. Appropriate accommodation to address the prohibition of the use of these substances must be incorporated into a site-specific HASP.

3.4 Sample Area Access

Visitors, including contractors or site personnel, who are not following these general PFAS sampling program protocols shall not be allowed to approach within 35 feet of the sample area until PFAS sample collection activities are complete and the PFAS sample container has been enclosed in a Ziploc® storage bag and placed in the sample cooler.

3.5 Field Equipment Decontamination

Use the procedures in this section to decontaminate all non-dedicated sampling equipment (e.g., submersible pumps, bladder pump components, tubing shears, etc.) used to collect samples:

- Rinse thoroughly with Citranox solution
- Rinse thoroughly with de-ionized (DI) water
- Rinse with methanol
- Rinse with DI water
- Allow to air dry
- Store equipment in clean Ziploc® storage bag until needed for sampling

Decontamination fluids used to clean equipment including Citranox, DI water, and methanol shall not be reused during field decontamination and shall be collected and drummed for off-site disposal.

1.0 GENERAL APPLICABILITY

The purpose of this Standard Operating Procedure (SOP) is to describe the procedures that shall be followed during monitoring well purging and the collection of groundwater samples for analysis of per- and polyfluoroalkyl substances (PFAS).

This SOP includes the following:

- Monitoring Well Groundwater Elevation Measurement
- Monitoring Well Purge
- Sample Container Considerations
- Groundwater Sample Collection Procedures
- Sample Shipping Requirements

With the exceptions provided in these SOPs, field personnel shall follow the monitoring well purge protocols included in Section 4 of the Sampling and Analysis Plan (SAP) dated January 2018. Sampling depths for the monitoring wells included in this sampling program are included on Table 1.

2.0 RESPONSIBILITIES

The Field Team Leader and field personnel have the shared responsibility to oversee and ensure that the monitoring well purge and PFAS groundwater sampling program is performed in accordance with the program-specific protocols described in this SOP. The Field Team Leader shall ensure that field personnel understand and comply with this SOP.

3.0 PURGING AND SAMPLING PROCEDURES

3.1 Water Level Measurement

Under normal conditions, the first step in conducting a groundwater sampling program is to collect a synoptic round of static water level measurements and monitoring well sounded depths. However, due to the extremely low detection limits for PFAS, collection of a synoptic round of groundwater elevation measurements shall only be conducted after the groundwater sampling program has been completed to help mitigate the possibility of cross-contamination.

Field personnel shall record a depth to water measurement in each well prior to initiating well purge procedures.

3.2 Monitoring Well Purge

Field personnel shall not use Teflon® or low-density polyethylene (LDPE) tubing or other equipment containing these materials for purging or sample collection. High-density polyethylene (HDPE) tubing is preferred. Field personnel shall not re-use materials between well sample locations. Following completion of monitoring well purge activities at a monitoring well location, field personnel shall place all disposable materials in heavy-duty (i.e., lawn waste) garbage bags for disposal. Field personnel shall wear nitrile gloves at all times.

Field personnel shall purge monitoring wells using a submersible pump and HDPE tubing. Field personnel shall inquire of the manufacturer and identify a submersible pump model whose construction does not include any Teflon® components (e.g., check balls, O-rings, compression fittings, etc.). New HDPE tubing shall be used to purge groundwater at each bedrock well. Field personnel shall determine and cut the appropriate length of HDPE tubing to be used in each well using the previously measured arm span of the individual performing the monitoring well purge to avoid contact with any materials other than the well and submersible pump. Field personnel shall decontaminate non-dedicated components and sampling equipment (including pumps, tubing shears, etc.) in accordance with SOP-1 between well purge locations.

Purge water shall be collected and discharged to the publicly-owned treatment works at the on-site treatment building.

3.3 Sample Containers

Groundwater samples shall be collected in HDPE sample containers provided by the laboratory specifically for use in the collection samples for analysis of PFAS (i.e., HDPE without a Telfon® liner). Glass containers shall not be used due to the potential for loss of PFAS through adsorption.

Groundwater sample container lids shall remain on the sample container until immediately prior to sample collection and lids shall be resealed immediately following sample collection. Field personnel shall hold the sample container lid in their hand until the lid is replaced on the sample container. Field personnel shall not rinse groundwater sample container bottles during groundwater sample collection. Groundwater sample container labels shall be completed using a pen or a pencil after the lid has been re-secured on the sample container. Field personnel shall not use markers to complete sample container labels.

3.4 Sample Collection

With the exceptions provided in these SOPs, field personnel shall follow the groundwater sampling protocols included in Section 4 of the SAP dated January 2018. Field personnel shall wash their hands and put on a new pair of nitrile gloves prior to sample collection. Once the nitrile gloves are put on, field personnel shall not handle papers, pens, clothes, etc. prior to the collection of groundwater samples. If field personnel need to take notes or handle anything other than the sample container prior to collecting the sample, the old nitrile gloves with which contact was made shall be removed and new nitrile gloves put on.

Field personnel shall hold the sample container in such a manner that the sample container does not come in direct contact with the HDPE tubing or pump equipment. The sampling container shall be filled completely. If field personnel observe suspended solids in the collected groundwater sample, a new sample shall be collected, if possible. If it is not possible to collect a sample with minimal suspended solids (i.e., no evidence of solids settling at the bottom of the sampling container), field personnel shall contact the project manager and, if the sample is submitted for analysis, indicate the presence of suspended solids as a note on the chain-of-custody.

Groundwater samples shall be placed directly into the laboratory-supplied HDPE containers. Once the groundwater sample container lid has been resealed, groundwater sample containers are to be placed into individual new Ziploc® storage bags. Following groundwater sample collection, groundwater sample containers enclosed within their Ziploc® storage bags shall be placed on ice in the laboratory-

provided sample cooler. Field personnel shall minimize sample exposure to sunlight during sample handling and storage.

All sampling materials shall be treated as single use and disposed of following completion of groundwater sampling at each monitoring well location.

3.5 Sample Shipping

Groundwater sample containers shall be stored on ice and maintained at approximately 4 degrees Celsius (°C) and transported by overnight courier to the laboratory. Field personnel shall only use new, fresh ice. Reusable chemical or gel ice packs shall not be used, as these may contain PFAS. Tracking numbers for all shipments shall be provided once the sample coolers have been shipped to ensure their timely delivery.

1.0 GENERAL APPLICABILITY

The purpose of this Standard Operating Procedure (SOP) is to describe the Quality Assurance / Quality Control (QA/QC) samples that shall be collected during a per- and poly-fluoroalkyl substances (PFAS) sampling program.

This SOP includes protocols for the collection of the following QA/QC samples:

- Equipment Blanks
- De-ionized Water Blanks
- Field Duplicates
- Field Blanks
- Trip Blanks
- Analytical QA/QC

2.0 RESPONSIBILITIES

The Field Team Leader and field personnel have the shared responsibility to oversee and ensure that the PFAS QA/QC sampling program is performed in accordance with the program-specific protocols described in this SOP. The Field Team Leader shall ensure that field personnel understand and comply with this SOP.

Field personnel shall inquire of the submersible pump manufacturer and identify a pump model whose construction does not include any Teflon® components (e.g., check balls, O-rings, compression fittings, etc.).

3.0 QA/QC PROTOCOLS

3.1 Equipment Blanks

Equipment blanks shall be collected at a rate of one per setup per event for non-dedicated sampling equipment (i.e., submersible pumps). Equipment blanks shall be collected using laboratory-supplied De-ionized (DI) water and shall be collected in laboratory-supplied high-density polyethylene (HDPE) containers.

After decontamination of the submersible pump in accordance with the procedure described in SOP-1, equipment blanks will be collected by pouring the laboratory supplied DI water into a new and unused HDPE sample bottle and then pumping the DI water through new HDPE tubing and new silicon tubing with the submersible pump into the sample container. When the sample container is full, replace the sample container lid and re-seal. Equipment blank container lids shall remain in the hand of field personnel until replaced on the sample container. Sample container labels shall be completed using a pen or pencil after the sample container lid has been resealed. Field personnel shall not use markers to complete sample container labels.

3.2 De-ionized Water Blanks

DI water blanks shall be collected at a rate of one per setup per event for non-dedicated sampling equipment (i.e., submersible pumps). DI water blanks shall be collected using DI water and shall be collected in laboratory-supplied HDPE containers.

After decontamination of the submersible pump in accordance with the procedure described in SOP-1, DI water blanks will be collected by pouring the DI water used for decontamination over the external portion of the submersible pump into the sample container. When the sample container is full, replace the sample container lid and re-seal. DI water blank container lids shall remain in the hand of field personnel until replaced on the sample container. Sample container labels shall be completed using a pen or pencil after the sample container lid has been resealed. Field personnel shall not use markers to complete sample container labels.

3.3 Field Duplicates

Field personnel shall collect one blind field duplicate for every 20 primary field samples collected. Field personnel shall collected field duplicates immediately after collection of the primary field samples. Field duplicates shall be collected in the laboratory-supplied PFAS-free HDPE sample containers. Field duplicate container lids shall remain in the hand of field personnel until replaced on the sample container. Sample container labels shall be completed as described above.

Field personnel shall collect groundwater field duplicates for analysis of PFAS using the following procedures:

- Field personnel shall stabilize groundwater parameters in accordance with the AIWP SAP and SOP-2.
- Field personnel shall collect the primary sample in accordance with the AIWP SAP and SOP-2.
- Following collection of the primary sample, change gloves and prepare to collect the field duplicate.
- Field duplicates shall be collected immediately following collection of the primary sample.
- Completely fill the laboratory-provided HDPE groundwater sample container.
- Replace and re-seal the lid on the groundwater sample containers, then complete the sample container label as described above.

3.4 Field Blanks

Field personnel shall submit of one field blank per day of sampling. Field blanks shall consist of DI water containerized in an HDPE sample container filled at the laboratory prior to beginning the field program. Field blank sample containers shall be opened during the collection of a sample and the laboratory-supplied DI water contained therein shall be poured directly into a laboratory-supplied HDPE sample container, then resealed. Field blank container lids shall remain in the hand of field personnel until replaced on the sample container. Sample container labels shall be completed as described above.

3.5 Trip Blanks

Field personnel shall submit one laboratory-supplied trip blank per day of sampling. Trip blanks shall consist of PFAS-free water containerized in an HDPE sample container filled at the laboratory prior to the beginning of the field program. Field personnel shall place one trip blank container in the sample cooler at the beginning of the day and the trip blank shall remain in the cooler for the duration of sampling activities conducted on that day. Trip blank containers shall be submitted to the laboratory with the daily field sample shipment.

3.6 Analytical QA/QC

Internal laboratory QA/QC shall consist of one laboratory blank and one matrix spike / matrix spike duplicate (MS/MSD) for every 20 primary field samples collected for analysis. Field personnel shall collected MS/MSDs immediately after collection of the primary field samples as described above for field duplicates.

As part of the internal QA/QC, relative percent difference (RPD) shall be calculated between samples and corresponding field or laboratory duplicates. The laboratory quality assurance portion of the laboratory certificates shall be reviewed to verify that all calculations/recoveries were within acceptable limits as established by the laboratory method.

3.7 Sample Shipping

QA/QC samples shall be maintained at a temperature between 0 and 4 °C during shipping. Only new, fresh ice may be used in sample coolers. Field personnel shall not use reusable chemical or gel ice packs, as these may contain PFAS. Samples shall be shipped via courier service with priority overnight delivery. Tracking numbers for all shipments shall be provided once they have been sent out so to ensure their timely delivery.

ATTACHMENT B

LOW-FLOW GROUNDWATER PURGE/SAMPLE FIELD INFORMATION FORM

ATTACHMENT B

LOW-FLOW GROUNDWATER PURGE/SAMPLE FIELD INFORMATION FORM

Site _____

Location: _____

Project Number: _____ Meter/Type/Serial #: _____

MONITORING WELL ID: _____ Meter Calibrated @: _____

Depth to Water Prior to Purging [ft-bmp]: _____ Sampling Date/Time: _____

Well Casing Diameter [in]: _____ Sampler(s): _____

Start Time (purging): _____ Sampling Device: _____

Purging Device: _____ Sampling Purge Rate: _____

Pump intake setting: _____ Sample Characteristics: _____

Well Screen Interval: _____ PID Measurement of Well Headspace (ppm): _____

As-Built Construction Well Depth [ft-bmp]: _____ Analytical Parameters: _____

Sounded Well Depth [ft-bmp]: _____ _____

Weather Conditions: _____ Fe+2 result (field measurement): _____ PPM

Time [hh:mm]	Temperature [°C]	pH [std]	Specific Conductance Circle One [S/m] or [mS/cm]	Turbidity [ntu]	Dissolved Oxygen [mg/l]	Redox Potential Note - Indicate if (+) or (-) [mV]	Depth To Water [ft-bmp]	Volume Purged [liters]	Approximate Purge Rate [ml/min]	Observations (PID readings, sample characteristics, equipment problems, etc.)

Comments:

Signature:

Page __ of __

ATTACHMENT C

VOLUME AVERAGE GROUNDWATER PURGE/SAMPLE FIELD INFORMATION FORM

ATTACHMENT C

Volume Average Groundwater Purge/Sample Field Information Form

Site: _____

Location: _____

Project Number: _____

Sampling Team: _____

Sample Point ID: _____

Purging Device: _____

Depth to water before purging (ft-bmp) _____ Date: _____ Time: _____

Well depth (ft-bmp) _____

Casing Volume Calculation

Casing diameter (in)	2"	4"	6"	8"
Casing volume (gal)	0.163 gal/ft	0.653 gal/ft	1.47 gal/ft	2.61 gal/ft

Volume purged (gal) _____ Time Start: _____ Time Finish: _____

Depth to water after purging (ft-bmp) _____

Remarks:

WELL INSPECTION (Circle Y or N)

Is well location correct on map?	Y or N	Is the well locked?	Y or N
Is well located in a dry area?	Y or N	Is the lock in good condition?	Y or N
Is well readily accessible?	Y or N	Is the well vented?	Y or N
Is well legibly labeled?	Y or N	Does casing have weep hole?	Y or N
Is well protected with posts?	Y or N	Does well have dedicated bailer?	Y or N
Is casing free of kinks/bends?	Y or N	Does well have dedicated pump?	Y or N
Is protective casing secure?	Y or N	Is equip. in good condition?	Y or N

Remarks:

FIELD MEASUREMENTS					Units	Calibration Notes
Temp.	1) _____	2) _____	3) _____	4) _____	**ºC**	
pH	1) _____	2) _____	3) _____	4) _____	**std. units**	
Sp. Cond	1) _____	2) _____	3) _____	4) _____	**ms/cm**	
Turbidity	1) _____	2) _____	3) _____	4) _____	**ntu**	
Volume	1) _____	2) _____	3) _____	4) _____	**gallons**	
Other	1)	2)	3)	4)		

Sample Collection Notes:

Weather conditions at time of sampling:

Sample characteristics:

Sample date / time: Method of sample collection:

Sample sequence:

Signature: _____ Company: _____ Date: _____

ATTACHMENT D

TESTAMERICA

Cover Page:

Quality Assurance Manual

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Title Page:

Quality Assurance Manual
Approval Signatures

Ann Gladwell

Date: 9/25/09

Laboratory Director – Ann Gladwell

Date: 9/25/09

Quality Manager - Carl Armbruster

Date: 9/25/09

Operations Manager - Mark Acierno

SECTION 2

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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
CW-Q-S-001	Corporate Document Control and Archiving
CW-Q-S-002	Writing a Standard Operating Procedure (SOPs)
CA-L-S-001	Internal Investigation of Potential Data Discrepancies and Determination for Data Recall
CA-L-S-002	Subcontracting Procedures
CA-L-P-001	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
ED-GEN-001	Data Management and Handling Procedures
ED-GEN-002	Document Control
ED-GEN-003	Control of Non-Conformances and Corrective Action
ED-GEN-007	Subsampling
ED-GEN-011	Calibration and Use of Laboratory Pipettes
ED-GEN-014	Thermometer Calibration
ED-GEN-021	Data Review
ED-GEN-022	Training
ED-GEN-024	Record Storage and Retention
ED-RP-001	Reports Production
ED-SPM-001	Sample Receipt, Login, Identification and Storage
ED-SPM-006	Procedure for Acceptance and Handling of Regulated Domestic and Foreign Soil
ED-SPM-007	Disposal of Samples and Associated Laboratory Waste

Company Confidential & Proprietary

SECTION 3

INTRODUCTION *(NELAC 5.1 - 5.3)*

3.1 INTRODUCTION AND COMPLIANCE REFERENCES

TestAmerica Edison'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 2003 National Environmental Laboratory Accreditation Conference (NELAC) standards and ISO/IEC Guide 17025 (1999). 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.
- EPA SW-846, *Test Methods for the Evaluation of Solid Waste, 3rd Edition,* September 1986; Update I, July 1992; Update II, September 1994; and Update III, December 1996.
- Federal Register, 40 CFR Parts 136, 141, 172, 173, 178, 179 and 261.
- USEPA Contract Laboratory Program. *Statement of Work for Inorganics Analysis. Multi-Media, Multi-Concentration.* Document ILM04.0.
- USEPA Contract Laboratory Program. *Statement of Work for Organics Analysis. Multi-Media, Multi-Concentration.* Document Number OLMO3.1, August 1994.
- APHA, *Standard Methods for the Examination of Water and Wastewater,* 18th Edition, 19th, 20th and 21st Edition.

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 drinking water, effluent water, groundwater, hazardous waste, sludge and soils. The Quality Assurance Program contains specific procedures and methods to test samples of differing matrices for chemical and physical parameters. The Program also contains guidelines on maintaining documentation of analytical process, reviewing results, servicing clients and tracking samples through the laboratory. The technical and service requirements of all requests to provide analyses 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 used by the laboratory can be found in TestAmerica Edison Work Instruction EDS-WI-009 (Edison Analytical Capabilities). The approach of this manual is to define the minimum level of quality assurance and quality control necessary to meet 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

This manual 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 by the senior laboratory management staff. The laboratory updates and approves such changes according to our Document Control & Updating procedures (refer to SOP No. ED-GEN-002).

SECTION 4

ORGANIZATION AND MANAGEMENT *(NELAC 5.4.1)*

4.1 OVERVIEW

TestAmerica Edison 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. TestAmerica Edison has day-to-day independent operational authority overseen by corporate officers (e.g., President, Chief Operating Officer, Corporate Quality Assurance, etc.). The TestAmerica Edison laboratory operational and support staff work under the direction of the Laboratory Director. The organizational structure for both Corporate & TestAmerica Edison 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 Quality Assurance Program

The responsibility for quality lies 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 Edison laboratory.

4.2.2 Laboratory Director/Lead Technical Director

TestAmerica Edison's Laboratory Director is responsible for the overall quality, safety, financial, technical, human resource and service performance of the whole laboratory and reports to the General Manager (GM). The Laboratory Director provides the resources necessary to implement and maintain an effective and comprehensive Quality Assurance and Data Integrity Program.

Specific responsibilities include, but are not limited to:

- Serves as lead technical director for all fields of testing.
- Ensures that all analysts and supervisors have the appropriate education and training to properly carry out the duties assigned to them and ensures that this training has been documented.
- Ensures that personnel are free from any commercial, financial and other undue pressures which might adversely affect the quality of their work.
- Ensures TestAmerica's human resource policies are adhered to and maintained.

- Ensures that sufficient numbers of qualified personnel are employed to supervise and perform the work of the laboratory.
- Ensures that appropriate corrective actions are taken to address analyses identified as requiring such actions by internal and external performance or procedural audits. Procedures that do not meet the standards set forth in the QAM or laboratory SOPs may be temporarily suspended by the Laboratory Director.
- Monitors standards of performance in quality control and quality assurance.
- Monitors the validity of analyses performed and data generated in the lab to assure reliable data.
- Reviews and approves all SOPs prior to their implementation and ensures all approved SOPs are implemented and adhered to.
- Interfaces with Project Management and Customer Service to forecast receipts, provide quality analytical data to clients and meet on-time delivery dates.
- Ensures that the facility has appropriate Information Technology resources and that they are used effectively to support operational requirements.
- Actively participates in the process of sharing and adopting best practices within TestAmerica. Provides technical assistance to other TestAmerica laboratories as needed to improve productivity and customer service.
- Ensures client specific reporting and quality control requirements are met.
- Captains the management team, consisting of the QA Manager, the Operations Manager, the Project Management Director, the Client Services Manager, the Service Center Manager, the Environmental, Health and Safety Manager and the Support Services Manager as direct reports.

4.2.3 Quality Assurance (QA) Manager

The QA Manager has responsibility and authority to ensure the continuous implementation of the quality system based on ISO 17025.

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 (i.e., managerial) influence. Corporate QA may be used as a resource in dealing with regulatory requirements, certifications and other quality assurance related items. The QA Manager directs the activities of the QA staff to accomplish specific responsibilities, which include, but are not limited to:

- 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.
- 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 and conducting the annual internal audits of quality systems and lab technical operations.
- 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 are temporarily suspended following the procedures outlined in Section 13.
- Monitoring standards of performance in quality control and quality assurance.
- Coordinating of document control of SOPs, MDLs, control limits, and miscellaneous forms and information.
- Review and approval of MDL studies.
- Review and approval of analyst Demonstrations of Capability (IDOC/CDOC).
- Review and approval of statistical control limit evaluations.
- Maintenance of quality reference limits in LIMS (TALS).
- 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.

4.2.4 Quality Assurance (QA) Specialist

The Quality Assurance (QA) Specialist is responsible for performing data audits, special audits, assisting with external and systems audits, overseeing the maintenance of QC records, certifications, Standard Operating Procedures (SOPs), training records, DOCs, arranging and managing PT samples. Additional responsibilities may include assisting with systematic problems within the laboratory, assisting in reviewing and/or writing of Quality Assurance Project Plans, and technical and QC specifications in contracts and other functions in support of the QA Manager's responsibilities as assigned.

- Assist QA Manager in conducting QA training courses, including ethics training.

- Performs data audits.
- Assist in performing special audits as deemed necessary by data audits, client inquiries, etc.
- Assisting in, conducting and responding to external audits conducted by clients and regulatory agencies.
- Assisting in reviewing and/or writing of Quality Assurance Project Plans, and technical and QC specifications in contracts.
- Maintaining all necessary laboratory certifications.
- Arranging and managing PT samples.
- Reviewing laboratory SOPs. Writing SOPs as needed.
- Maintaining historical indices of all technical records including SOPs, QC records, laboratory data, etc.
- Ensuring maintenance of records archives.
- Assisting in and monitoring laboratory's method compliance.
- Ensuring maintenance of DOCs for all analysts.
- Ensuring maintenance of training records for all employees.
- Assisting in identification of systematic problems within laboratories.
- Recommends resolutions for ongoing or recurring nonconformance.
- Providing statistical feedback to departments on error rates, and assisting in identifying systematic improvements to minimize errors.
- Assists in tracking of customer complaints, providing statistical feedback to the laboratory, and assisting in identifying improvements.
- Overseeing and reviewing MDL studies.
- Ensuring control charts are generated; oversees and approves setting of control limits.
- Assists in monitoring new regulations and communicating them to the laboratory.

4.2.5 LAN Analyst

The LAN Analyst reports directly to the Regional Desktop Support Supervisor. Responsibilities include:

- Works with Corporate IT to solve information systems problems and to standardize laboratory IT equipment and processes.
- Monitors and supports office automation so that LAN is operational for internal and external communications.
- Troubleshoots problems throughout laboratory relating to computers, software, telephones and other electronic equipment.
- Responsible for new user setup on network, LIMS, telephone and voice mail.

- Installs or upgrades computers and other equipment.
- Maintains tape backups for multiple computer servers including LIMS.
- Maintains historical files of software, software operating procedures (manuals), software changes/modifications (Change Log) and software version numbers.
- Maintains log of repairs and service performed on LIMS hardware.
- Maintains awareness of any environmental conditions of the facility housing the LIMS that may compromise LIMS raw data and informs management.

4.2.6 Operations Manager

The Operations Manager manages and directs the analytical and reports production sections of the laboratory. He/She reports directly to the Laboratory Director. Specific responsibilities include:

- Maintains awareness of any environmental conditions of the facility housing the LIMS that may compromise LIMS raw data and informs management.
- Continuously evaluates production capacity and improves capacity utilization.
- Continuously evaluates turnaround time and addresses any problems that may hinder meeting the required and committed turnaround time from the various departments.
- Develops and improves the training of all analysts in cooperation with the Laboratory Director and QA Manager and in compliance with regulatory requirements.
- Works with the Department Managers to ensure that scheduled instrument maintenance is completed.
- Is responsible for efficient utilization of supplies.
- Constantly monitors and modifies the processing of samples through the departments.
- Fully supports the quality system and, if called upon in the absence of the QA Manager, serves as his substitute in the interim.

4.2.7 Environmental, Health and Safety Manager

The Environmental, Health and Safety Manager reports directly to the Laboratory Director. The duties of this position consist of:

- Supervises the Environmental, Health and Safety/Facilities Team.
- Conduct ongoing, necessary safety training and conduct new employee safety orientation.
- Assist in developing and maintaining the Chemical Hygiene/Safety Manual.
- Administer dispersal of all Material Safety Data Sheet (MSDS) information.
- Perform regular chemical hygiene and housekeeping instruction.
- Give instruction on proper labeling and practice.
- Serve as chairman of the laboratory safety committee.
- Provide and train personnel on protective equipment.

- Oversee the inspection and maintenance of general safety equipment – fire extinguishers, safety showers, eyewash fountains, etc. and ensure prompt repairs as needed.
- Supervise and schedule fire drills and emergency evacuation drills.
- Determine what initial and subsequent exposure monitoring, if necessary to determine potential employee exposure to chemicals used in the laboratory.
- When determined necessary, conduct exposure monitoring assessments.
- Determine when a complaint of possible over-exposure is "reasonable" and should be referred for medical consultation.
- Assist in the internal and external coordination of the medical consultation/monitoring program conducted by TestAmerica's medical consultants.
- Staying current with the hazardous waste regulations.
- Continuing training on hazardous waste issues.
- Reviewing and updating annually the Hazardous Waste Contingency Plan in the Environmental Health & Safety Manual.
- Auditing the staff with regard to compliance with the Hazardous Waste Contingency Plan.
- Contacting the hazardous waste subcontractors for review of procedures and opportunities for minimization of waste.

4.2.8 EH&S/Facilities Coordinator

The EH&S/Facilities Coordinator reports directly to the Environmental, Health and Safety Manager. The duties of this position consist of:

- Monitors laboratory for unsafe conditions or acts to keep lab in compliance with the Chemical Hygiene Plan, EH&S Procedures, and company policies.
- Ensures the proper personal protective equipment is available and personnel are properly trained in its use.
- Assists the Environmental, Health and Safety Manager in the investigation of accidents, incidents, and near misses and identifies and eliminates root cause.
- Conducts monthly facility inspections for compliance with health, safety and environmental regulations and procedures. Completes and forwards monthly inspection report to safety committee and laboratory management for corrective actions.
- Conducts safety equipment checks to ensure proper working order and sufficient inventory.
- Plans and tracks completion of monthly general awareness training sessions and compliance training, including new employee EH&S orientation.
- Coordinates emergency response team to provide prompt medical attention and stabilize emergency situation. After emergency is over, assists in determining appropriate clean up procedures.

- Conducts the monthly EH&S committee meeting.
- Participates in monthly EH&S conference call.
- Reviews and maintains MSDS's for laboratory materials.
- Coordinates the management and disposal of laboratory wastes.
- Assists in the preparation and maintenance of the laboratory Integrated Contingency Plan.
- Monitors air quality in facility, including monitoring fumehoods for proper operation and ventilation.
- Maintains overall building facilities and equipment as well as administers prevention maintenance measures.
- Contacts outside contractors as necessary to repair/maintain items outside the realm of reasonable maintenance.
- Performs miscellaneous errands, buying parts for labs, janitorial supplies.
- Oversees storage facilities, files and outside storage.

4.2.9 Department Managers

Department Managers report to the Operations Manager and typically serve as the Technical Director of their respective departments. Responsibilities include:

- Ensure that analysts in their department adhere to applicable SOPs and the QA Manual. They perform frequent SOP and QA Manual review to determine if analysts are in compliance and if new, modified, and optimized measures are feasible and should be added to these documents.
- Participates in the selection, training (including familiarization with SOP, QC, Safety, and computer systems), development of performance objectives and standards of performance, appraisal (measurement of objectives), scheduling, counseling, discipline, and motivation of analysts. Ensure the documentation of these activities in accordance with systems developed by the QA and Personnel Departments.
- Provide technical guidance to analysts in resolving problems encountered daily during sample prep/analysis in conjunction with the Operations Manager, and/or QA Manager.
- Ensures that 100% of data review undergoes two documented levels of review. Likewise ensures that all non-conformance issues are properly documented.
- Responsible for the timely and accurate completion of performance evaluation samples and MDLs, for the department.
- Ensure all logbooks are maintained, current, and properly labeled or archived.
- Report all non-conformance conditions to the QA Manager, Operations Manager, and/or Laboratory Director.
- Ensure that preventive maintenance is performed on instrumentation as detailed in the QA Manual or SOPs. He is responsible for developing and implementing a system for preventive maintenance, troubleshooting, and repairing or arranging for repair of instruments.

- Maintain adequate and valid inventory of reagents, standards, spare parts, and other relevant resources required to perform daily analysis.
- Achieve optimum turnaround time on analyses and compliance with holding times.
- Provide written responses to external and internal audit issues.

4.2.10 Laboratory Analysts and Technicians

Laboratory analysts and technicians are responsible for conducting analysis and performing all tasks assigned to them by their department manager or supervisor. The responsibilities of the analysts are listed below:

- Perform analyses by adhering to analytical and quality control protocols prescribed by current SOPs, this QA Manual, and project-specific plans honestly, accurately, timely, safely, and in the most cost-effective manner.
- Document standard and sample preparation, instrument calibration and maintenance, data calculations, sample matrix effects, and any observed non-conformance on worklists, benchsheets, lab notebooks and/or the Non-Conformance Database by means of Non-Conformance Memos (NCMs).
- Report all non-conformance situations, instrument problems, matrix problems and QC failures, which might affect the reliability of the data, to their Department Manager, the Laboratory Director, and/or the QA Manager or member of QA staff.
- Perform 100% review of the data generated and document the review in the raw data and on the review checklist prior to entering and submitting for secondary level review.
- Suggest method improvements to the Department Manager, the Laboratory Director, and the QA Manager. These improvements, if approved, will be incorporated within the constraints of the consensus reference methods.
- Work cohesively as a team in their department to achieve the goals of accurate results, optimum turnaround time, cost effectiveness, cleanliness, complete documentation, and personal knowledge of environmental analysis.
- Adhere to all environmental, health and safety protocols and attend safety meetings as required.
- Attend and participate in all staff meetings.

4.2.11 Sample Control Manager

The Sample Control Manager reports to the Laboratory Director. The responsibilities are outlined below:

- Direct the logging of incoming samples into the LIMS.
- Ensure the verification of data entry from login.
- Manages the preparation and shipment of bottle kits to clients.
- Oversees the responsibilities of all Sample Control Technicians.
- Supervises the storage and disposal of all samples.

4.2.12 Customer Service Manager

The Customer Service Manager reports to the Laboratory Director and serves as the primary interface between the laboratory and the Sales and Marketing staff. Responsibilities include:

- Laboratory's primary client representative.
- Ensures client complaints are handled professionally, and resolved in a timely manner.
- Compiles and interprets receipts forecast to show near term business trends.
- Manages a minimal list of projects/programs for key client accounts. (Note: sufficient time is needed to manage the PM group and the CSM must not be overwhelmed with project management.)
- Prepares proposals for new business opportunities.
- Compiles and interprets Bid Activity Report.
- Compiles and interprets receipts forecast to show near term business trends.
- Prepares proposals for new business opportunities.
- Provides general sales support to Account Executives for business development activities started in the field.
- Develops and maintains business materials and organized information resource files that include project descriptions, resumes, original proposals, boilerplates, and company qualifications materials.

4.2.13 Director of Project Management

The Director of Project Management reports to the Laboratory Director and serves as the interface between the laboratory's technical departments and the laboratory's clients. The staff consists of the Project Management team. With the overall goal of total client satisfaction, the functions of this position are outlined below:

- Technical training and growth of the Project Management team.
- Technical liaison for the Project Management team.
- Human resource management of the Project Management team.
- Responsible for ensuring that clients receive the proper sampling supplies, as appropriate.
- Accountable for response to client inquiries concerning sample status.
- Responsible for assistance to clients regarding the resolution of problems concerning COC.
- Ensuring that client specifications, when known, are met by communicating project and quality assurance requirements to the laboratory.
- Notifying the supervisors of incoming projects and sample delivery schedules.
- Accountable to clients for communicating sample progress in daily status meeting with agreed-upon due dates.

- Responsible for discussing with client any project-related problems, resolving service issues, and coordinating technical details with the laboratory staff.
- Responsible for staff familiarization with specific quotes, sample log-in review, and final report completeness.
- Monitor the status of all data package projects in-house to ensure timely and accurate delivery of reports.
- Inform clients of data package-related problems and resolve service issues.
- Coordinate requests for sample containers and other services (data packages).

4.2.14 Project Manager

The Project Managers report directly to the Director of Project Management and serve as liaisons between the laboratory and its clients. The Project Manager's responsibilities include:

- Ensure client specifications are met by communicating project and quality assurance requirements to the laboratory.
- Notify laboratory personnel of incoming projects and sample delivery schedules.
- Monitor the status of all projects in-house to ensure timely delivery of reports.
- Inform clients of project-related problems, resolving service issues and coordinating technical issues with the laboratory staff.
- Accountable for response to client inquiries concerning sample status.
- Responsible for assistance to clients regarding the resolution of problems concerning COC.
- Ensuring that client specifications, when known, are met by communicating project and quality assurance requirements to the laboratory.
- Notifying the supervisors of incoming projects and sample delivery schedules.
- Coordinate client requests for sample containers and other services.
- Schedule sample pick-ups from client offices or project sites and notifying the laboratory staff of incoming samples.
- Coordinate subcontract work.
- Respond to client inquiries concerning sample status.
- Performs final completeness review of data packages prior to release to client.

4.2.15 Project Management Assistant

The Project Management Assistant coordinates and monitors scheduling, timely completion and maintenance of project documentation files and completion of project set up and final report review, invoicing, and EDD's. Assists the Project Manager in servicing the client's needs. Specific responsibilities include:

- Reviews login confirmation reports for accuracy and corrects as needed.
- Generates diskettes for electronic data deliverables (EDD's) for electronic delivery to clients.

- Enters data that was subcontracted to other laboratories.
- Monitors report due dates for timely delivery.
- Assists Project Manager in changing compound lists, TAT, deliverables and other client specific requirements in the LIMs project and/or job database.
- Invoices completed data packages and generates credit or debit invoices to ensure proper payment.

4.2.16 Service Center Manager

The Service Center Manager (SCM) manages the service center and acts as a liaison between the laboratory and the local client base. The SCM is in charge of maintaining the Service Center facility, managing service center couriers, samplers and other personnel, and working with sales to develop, maintain and grow the client base in the area.

- Local area primary client representative for service center location.
- May head project start up meetings to ensure project objectives are successfully met and hands off project detail to assigned Project Manager(s).
- Works with the Quality Assurance Manager and Account Executives (AE) to evaluate and establish project requirements for the service center area.
- Ensures client complaints are handled professionally, and resolved in a timely manner.
- Is in charge of scheduling service center couriers and samplers, preparing bottle orders for delivery, scheduling sample pick ups and shipping samples to the designated laboratory for analysis.
- May manage a minimal list of projects/programs for key client accounts.
- Maintains the facilities at the service center and is responsible for all EH&S policies of TestAmerica at the service center.
- Responsible for all company vehicles that operate out of the service center.
- Provides general sales support to AEs for business development activities started in the field.
- Prepares proposals for new business opportunities.
- Orders supplies (bottles, coolers, etc.) for the service center

4.3 DEPUTIES

The following table defines who assumes the responsibilities of key personnel in their absence:

Key Personnel	Deputy
Laboratory Director	In the event of absence the Laboratory Director's responsibilities are shared by the Laboratory Operations Manager, the Quality Assurance Manager and the Client Services Manager, as appropriate.
Laboratory Operations Manager	Laboratory Director

Key Personnel	Deputy
QA Manager	Laboratory Director QA Specialist
Analytical Department Managers	Operations Manager
Client Services Manager/Director of Project Management	Laboratory Director
EH&S Manager	EH&S Coordinator
Sample Control Manager	Sample Control Supervisor
Service Center Manager	Field Services Supervisor

Figure 4-1.

Corporate and Laboratory Organization Charts

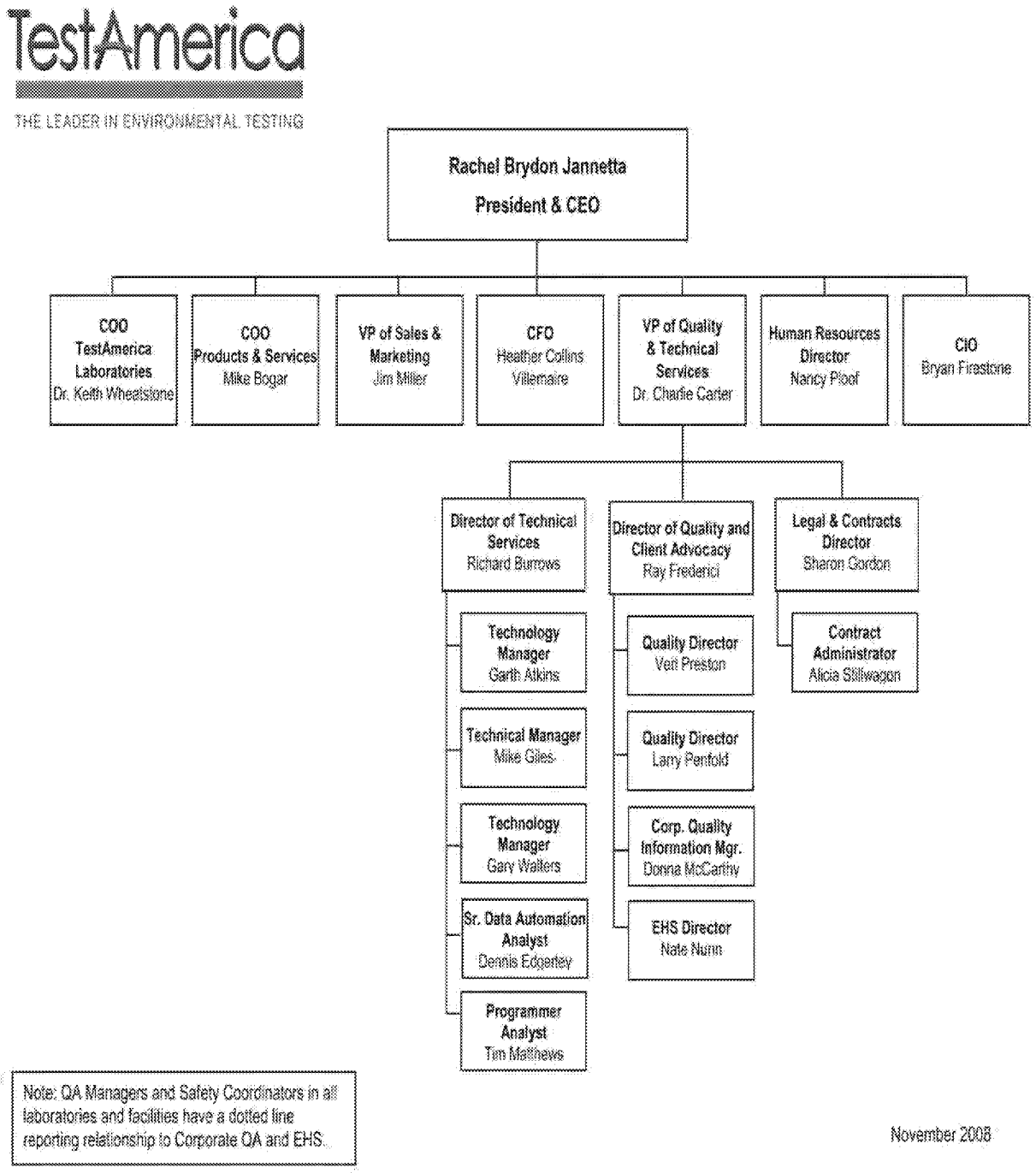
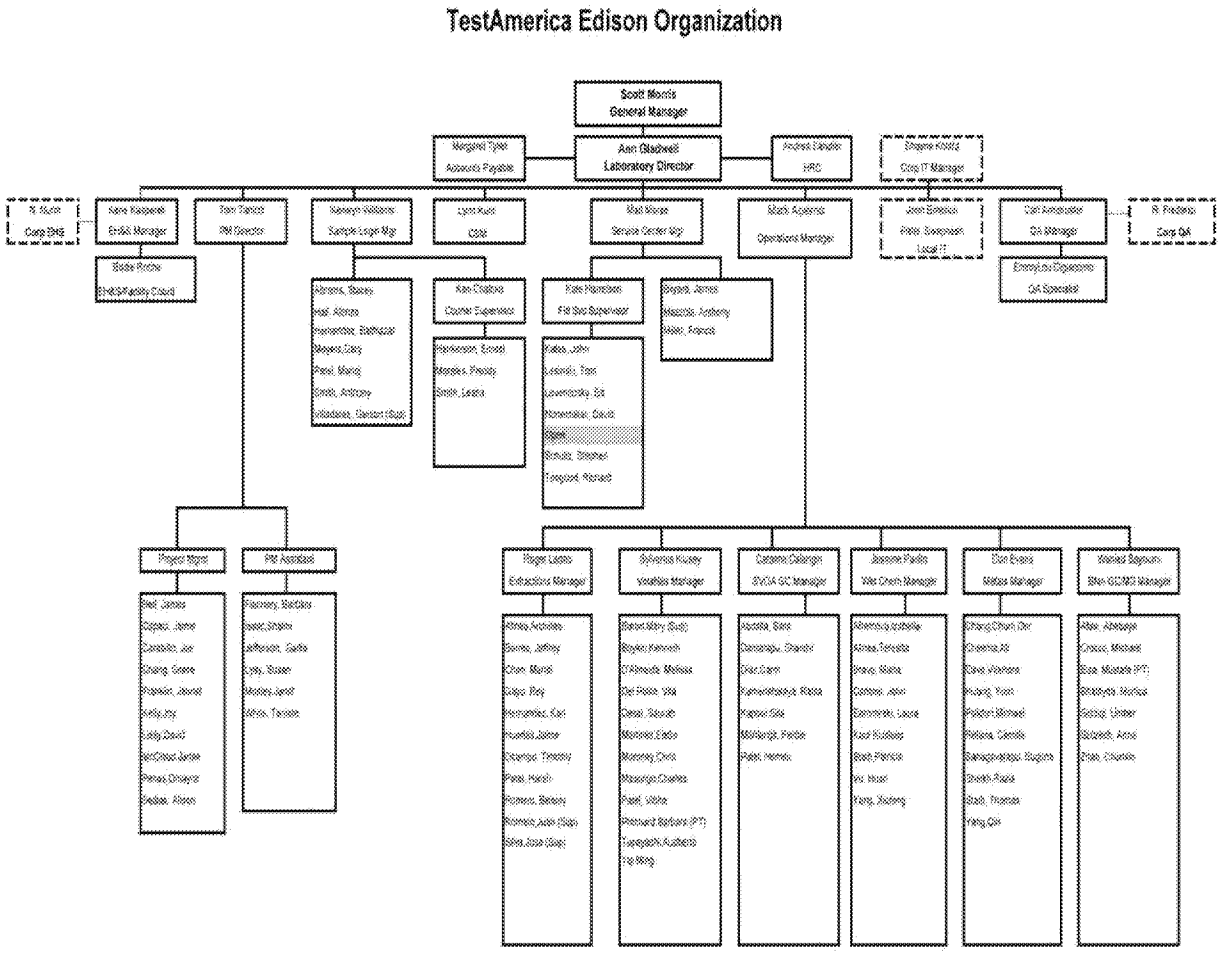


Figure 4-1. (continued)

Corporate and Laboratory Organization Charts



SECTION 5

QUALITY SYSTEM *(NELAC 5.4.2)*

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.

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. CA-L-P-001) 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. CA-L-S-001.)
- Procedures and guidance for recalling data if necessary (Corporate SOP No. CA-L-S-001).
- Effective external and internal monitoring system that includes procedures for internal audits (Section 16).
- 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
- Corporate Quality 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 Policy Memorandum
- Corporate Quality Management Plan (CQMP)
- Corporate SOPs and Policies
- Laboratory Quality Assurance Manual (QAM)
- Laboratory SOPs and Policies
- Other (Work Instructions (WI), memos, flow charts, etc.)

Note: The laboratory's 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 the QAPP. 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 being finalized. Additionally, the laboratory will provide support to the client for developing the sections of the QAPP that concern laboratory activities.

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 is 90% (or as specified by a particular project), expressed as the ratio of the valid data to the total data over the course of the project. Data will be considered valid if they are adequate for their intended use. Data usability 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 (Method Detection Limit) or quantified (Reporting Limit).

5.5 CRITERIA FOR QUALITY INDICATORS

The laboratory maintains Quality Control Limit tables within TALS (the laboratory's LIMS) that summarize the precision and accuracy acceptability limits for performed analyses. This summary includes an effective date, is updated each time new limits are generated and are managed by the laboratory's QA department. Unless otherwise noted, limits within these tables are laboratory generated. Some acceptability limits are derived from US EPA methods when they are required. Where US EPA method limits are not required, the laboratory has developed limits from evaluation of data from similar matrices. Criteria for development of control limits is contained in Section 25.

5.6 STATISTICAL QUALITY CONTROL

Statistically-derived precision and accuracy limits are required by selected methods (such as SW-846) and programs [such as the Ohio Voluntary Action Plan (VAP)]. The laboratory routinely utilizes statistically-derived limits to evaluate method performance and determine when corrective action is appropriate. The analysts are instructed to use the current limits in the laboratory (dated and approved by the QA Manager) and entered into the Laboratory Information Management System (LIMS). The Quality Assurance department maintains an archive of all limits used within the laboratory. If a method defines the QC limits, the method limits are used.

If a method requires the generation of historical limits, the lab develops such limits from recent data in the QC database of the LIMS following the guidelines described in Section 25. All calculations and limits are documented and dated when approved and effective. On occasion, a client requests contract-specified limits for a specific project.

Surrogate recoveries are determined for a specific time period as defined above. The resulting ranges are entered in LIMS.

Current QC limits are entered and maintained in the LIMS analyte database. As sample results and the related QC are entered into LIMS, the sample QC values are compared with the limits in LIMS to determine if they are within the acceptable range. 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 QA Manager evaluates these to determine if adjustments need to be made or for corrective actions to methods. All findings are documented and kept on file.

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 17). These metrics are used to drive continuous improvement in the laboratory's Quality System.

SECTION 6

DOCUMENT CONTROL *(NELAC 5.4.3)*

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 No. ED-GEN-002 (Document Control).

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 maintains control of records for raw analytical data and 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 (CARS). Raw analytical data consists of bound logbooks, instrument printouts, any other notes, magnetic media, electronic data and final reports.

6.2 DOCUMENT APPROVAL AND ISSUE

The pertinent elements of a document control system for each document include a unique document title and number, the number of pages of the item, 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. In order to develop a new document, a manager submits an electronic draft to the QA Department for suggestions and approval before use. Upon approval, QA personnel add the identifying version information to the document and retains the official document on file. The official document is provided to all applicable operational units (may include electronic access). Controlled documents are

identified as such and records of their distribution are kept by the QA Department. Document control may be achieved by either electronic or hardcopy distribution.

The QA Department maintains a list of the official versions of controlled documents.

Quality System Policies and Procedures will be reviewed at a minimum of every year 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 No. ED-GEN-002 (Document Control). Uncontrolled copies must not be used within the laboratory. Previous revisions and back-up data are stored by the QA department. Electronic copies are stored on the Public server in the QA folder and on the Edison intranet (EdiNET).

For changes to SOPs, refer to SOP No. CW-Q-S-002, Writing a Standard Operating Procedure SOP. The SOP identified above also defines the process of changes to SOPs.

Forms, worksheets, work instructions and information are organized by department in the QA office. A master list of work instructions is maintained by the QA department and electronic versions are kept on the network drive. The procedure for the care of these documents is in SOP ED-GEN-002 (Document Control).

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 No. ED-GEN-002 (Document Control).

SECTION 7

SERVICE TO THE CLIENT *(NELAC 5.4.7)*

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 regulatory and client 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 lab'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

Appropriate personnel will review the work request 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 National Account Director, 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 (not necessarily in the order below).

- Legal & Contracts Director
- General Manager
- The Laboratory Project Management Director
- The Laboratory Operations Manager
- Laboratory and/or Corporate Technical Directors
- Laboratory and/or Corporate Information Technology Managers/Directors
- Regional and/or National Account representatives
- Laboratory and/or Corporate Quality
- Laboratory and/or Corporate Environmental Health and Safety Managers/Directors
- The Laboratory Director reviews the formal laboratory quote and makes final acceptance for their facility.

The *National Account Director, Legal Contracts Director, or local account representative* then submits the final proposal to the client.

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 Legal & Contracts Director maintains copies of all signed contracts. *The applicable Project Manager maintains local copies of 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. These records are maintained in the project file by the Project Manager and/or Key Account Executive.

The contract will be distributed to and maintained by the appropriate sales/marketing personnel and the Regional Account Manager. A copy of the contract and formal quote will be filed with the laboratory PM and the Lab Director.

Records are maintained of pertinent discussions with a client relating to the client's requirements or the results of the work during the period of execution of the contract. The PM keeps a phone log of conversations with the client.

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. QA department involvement may be needed to assist in the evaluation of custom QC requirements.

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 the laboratory during production meetings. Such changes are updated to the project notes and are introduced to the managers at these meetings. The laboratory staff is then introduced to the modified requirements via the PM or the individual laboratory Department Manager. After the modification is implemented into the laboratory process, documentation of the modification is made in the case narrative of the data report(s).

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 16 and 26).

Note: ISO 17025/NELAC 2003 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 26. 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.

Technical Directors 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 *(NELAC 5.4.5)*

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 NELAC/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 Regional Account Executives (RAE) 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, such as the US Army Corps of Engineers and the USDA, require notification prior to placing such work.

8.2 QUALIFYING AND MONITORING SUBCONTRACTORS

Whenever a PM, Regional Account Executive (RAE) or Customer Service Manager (CSM) becomes aware of a client requirement or laboratory need where samples must be outsourced to another laboratory, the other laboratory(s) shall be selected based on the following:

- 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 and supporting documentation is available on the TestAmerica intranet site. Verify necessary accreditation, where applicable, (e.g., on the

subcontractors NELAC, A2LA accreditation or State Certification).

- 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, Account Executives or PMs may nominate a laboratory as a subcontractor based on need. The decision to nominate a laboratory must be approved by the Laboratory Director/Manager. The Laboratory Director/Manager 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 along with the associate documentation 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 Lab Directors/Managers, 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 (or RAE or CSM) 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 on a Subcontracted Sample Form (Figure 8-1) and the form is retained in the project folder. 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 Chain of Custody (COC). A copy of the original COC sent by the client must be included with all samples subbed within TestAmerica.

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. In the event this provision is utilized, the QA Manager will be required to verify certifications. 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_____
- A2LA (or ISO 17025) Certified: Yes_____No_____
- CLP-like Required: Yes_____No_____
  (Full doc required)
- Requested Sample Due Date: _____
  (Must be put on COC)

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 *(NELAC 5.4.6)*

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, 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. The analyst may check the item out of the on-site consignment system that contains items approved for laboratory use.

If an item is not available from the on-site consignment, the analyst must provide the master item number (from the master item list that has been approved by the Operations Manager), item description, package size, catalogue page number, and the quantity needed. If an item being ordered is not the exact item requested, approval must be obtained from the Operations Manager prior to placing the order. The Department Manager or the Laboratory Operations Manager places the order.

9.3.2 Receiving

It is the responsibility of the Facilities Coordinator to receive the shipment. It is the responsibility of the analyst who ordered the materials to date the material when received. Once the ordered reagents or materials are received, the analyst compares the information on the label or packaging to the original order to ensure that the purchase meets the quality level specified. 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

All 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, it may be assumed that it is not significant in that procedure and, therefore, any grade reagent may 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 unless noted otherwise by the manufacturer or by the reference source method. Chemicals should not be used past the manufacturer's or SOPs expiration date unless 'verified' (refer to item 3 listed below).

- An expiration date can not be extended if the dry chemical is discolored or appears otherwise physically degraded, the dry chemical must be discarded.

- Expiration dates can be extended if the dry chemical 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 is used for the preparation of standards, the expiration dates can be extended 6 months if the dry chemical is compared to an unexpired independent source in performing the method and the performance of the dry chemical is found to be satisfactory. The comparison must show that the dry chemical meets CCV limits. The comparison studies are maintained

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 500 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- mmho/cm (or specific resistivity of greater than 1.0 megaohm-cm) at 25°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 Department Managers/Supervisors 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 VOA vials must be certified clean and the certificates must be maintained. If uncertified VOA vials are 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 files or binders 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 Technical Director 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 Operations Manager and/or 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 the Laboratory Operations Manager places the order.

Upon receipt of a new or used piece of equipment, an equipment asset tag is affixed and the equipment is assigned a unique instrument ID ('BNAMS12', for example) that will be used to identify the instrument in LIMS and in logbooks. The instrument/equipment ID number is provided to the QA department which maintains the master laboratory equipment list. The IT department is also be notified so that the instrument can be added to the routine data back-up schedule. 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 20). For software, its operation must be deemed reliable and evidence of instrument verification must be retained by the IT Department or QA Department. Software certificates supplied by the vendors are filed with the IT Department. 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 21. The need for service is determined by analysts and/or Department Managers. The service providers that perform the services are approved by the Laboratory Director and/or the Laboratory Operations 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

<RESERVED>

SECTION 11

COMPLAINTS *(NELAC 5.4.8)*

11.1 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 13 (Corrective Actions) and is documented following the procedures in TestAmerica Edison SOP No. ED-GEN-003 (Control of Non-Conformances and Corrective Action).

11.2 EXTERNAL COMPLAINTS

An employee that receives a complaint initiates the complaint resolution process by first documenting the complaint according to TestAmerica Edison SOP No. ED-GEN-003 (Control of Non-Conformances and Corrective Action.

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.

11.3 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 13. 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 13.

11.4 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 17).

SECTION 12

CONTROL OF NON-CONFORMING WORK *(NELAC 5.4.9)*

12.1 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 13).

Due to the frequently unique nature of environmental samples, sometimes departures from documented policies and procedures are needed. When an analyst encounters such a situation, the problem is presented to the Department Manager for resolution. The manager may elect to discuss it with the Lab Director and/or QA Manager or have a representative contact the client to decide on a logical course of action. Once an approach is agreed upon, the analyst documents it using the laboratories corrective action system described in Section 13. This information can then be supplied to the client in the form of a footnote or a case narrative 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. Based on a technical evaluation, the lab may accept or opt to reject the request based on technical or ethical merit. An example might be the need to report a compound that the lab does not normally report. The lab would not have validated the method for this compound following the procedures in Section 20. The client may request that the compound be reported based only on the calibration. Such a request would need to be approved by the Lab Director and QA Manager, documented and included in the project folder. Deviations **must** also be noted on the final report with a statement that the compound is not reported in compliance with NELAC (or the analytical method) requirements and the reason. Data being reported to a non-NELAC state would need to note the change made to how the method is normally run.

12.2 RESPONSIBILITIES AND AUTHORITIES

TestAmerica's Corporate SOP entitled *Internal Investigation of Potential Data Discrepancies and Determination for Data Recall* (SOP No. CA-L-S-001) 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.

Under certain circumstances, the Laboratory Director, the Lab Operations Manager, a 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 well documented using the laboratory's corrective action procedures. This information may also be documented in logbooks and/or data review checklists as appropriate. 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, Laboratory Operations Manager, the QA Manager, and the Department 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, Laboratory Operations Manager, 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.

12.3 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. CA-L-S-001) 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. CA-L-S-001.

12.4 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. On a monthly basis, 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.

12.5 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 12.2, 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 13 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, Laboratory Operations Manager, QA Manager, Department 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 13

CORRECTIVE ACTION *(NELAC 5.4.10)*

13.1 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 Data Inquiry, Client Complaint and Corrective Action Report Form (CAR) (TestAmerica Edison Work Instruction No. EDS-WI-012) (refer to Figure 13-1).

13.2 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.

13.2.1 Data Inquiry/Client Complaint – The CAR form 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

13.2.2 Corrective Action Report (CAR) – The CAR form is also used to document the following types of corrective actions:

- Questionable trends that are found in the monthly review of NCRs.
- Issues found while reviewing NCRs that warrant further investigation.
- Internal and external audit findings
- Failed or unacceptable PT results.
- Corrective actions that cross multiple departments in the laboratory.
- Systematic reporting / calculation errors

13.3 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.

13.3.1 Cause Analysis

- Upon discovery of a non-conformance event, the event must be defined and documented. A CAR must be initiated, someone is assigned to investigate the issue and the event is investigated for cause. Table 13-1 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 Department Manager, Laboratory Director, Laboratory Operations Manager, or QA Manager (or QA designee) is consulted.

13.3.2 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 CAR is used for this documentation.

13.3.3 Monitoring of the Corrective Actions

- The Department Manager/Supervisor 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. Department Managers are accountable to the Laboratory Director to ensure final acceptable resolution is achieved and documented appropriately.
- Each CAR is entered into a database for tracking purposes and a monthly summary of all corrective actions is printed out for review to aid in ensuring that the corrective actions have taken effect.
- The QA Manager reviews monthly CARs for trends. Highlights are included in the QA monthly report (refer to Section 17). 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.

13.3.4 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 16.2.4, Special Audits.)

13.4 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 12). The documentation of these procedures is through the use of a CAR.

Table 12-1 includes examples of general technical corrective actions. For specific criteria and corrective actions, refer to the analytical methods or specific method SOPs. The QA Department also maintains various Work Instructions detailing lab specific technical criteria (ex., laboratory generated QC limits).

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 20 and 21. 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 and appropriate corrective action (e.g., reanalysis) is taken and documented.

13.5 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 13-1.
Corrective Action Report

TestAmerica Edison

Data Inquiry Request Form / Corrective Action Form

Date Initiated:	Job #:	Send Response to:
Date Needed:	Analyses:	Name:
		Address:
Client:	Lab :	
	Deliverable / Report Type	Phone:
Contact:	PDF/EDD ____ Full ____	FAX:
	Bound ____ Reduced ____	Email:
	Unbound ____ ResQA ____	
Project:	CD ____ Other ____	Send Via: FAX Mail UPS Email Courier

1. Type of Non-Conformance:

____ Missing Sample/Analysis	____ Results in Question	____ Insufficient Data for Validation	____ EDD
____ Wrong Sample Identification	____ Holdtime Violation	____ Explanation of Analysis	____ OTHER
____ Missing Pages	____ Calibration in Question		

2. Explanation of Details:

Initiator Signature:		Date:	

3. Required Actions: **Actions Completed:**

√ if needed	Department	Actions Required:	Initials:	Date:
	PM			
	LOGIN			
	VOAGC/MS			
	BNAMS			
	PEST/BNAGC			
	METALS			
	WETCHEM			
	SUBWORK			
	IT			
	ORG PREP			
	RP			

4. Final Approval of Data Inquiry Actions Taken:

Initiator Signature:		Date:	

5. LAB ERROR YES ___ NO ___ (IF YES, PLEASE COMPLETE SECTIONS 5 - 7) **CORRECTIVE ACTION ID#:**

6. Quality Assurance Review and Assignment of Further Action: *(to be completed by QA Manager - use page 2 if needed)*

Recommended Corrective Action:

7. Final Resolution of Corrective Action: *(to be completed by Dept. Supervisor - use page 2 if needed)*

Supervisor Signature:		Date:	

8. Quality Assurance Final Approval *(QA Manager or designee use only)*

QA Signature:		Date:	

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Table 13-1.

General Corrective Action Procedures

QC Activity ***(Individual Responsible for Initiation/Assessment)***	**Acceptance Criteria**	**Recommended Corrective Action**
Initial Instrument Blank *(Analyst)*	- Instrument response < MDL.	- Prepare another blank. - If same response, determine cause of contamination: reagents, environment, instrument equipment failure, etc..
Initial Calibration Standards *(Analyst, Supervisor)*	- Correlation coefficient > 0.99 or standard concentration value. - % Recovery within acceptance range. - See details in Method SOP.	- Reanalyze standards. - If still unacceptable, remake standards and recalibrate instrument.
Independent Calibration Verification (Second Source) *(Analyst, Supervisor)*	- % Recovery within control limits.	- Remake and reanalyze standard. - If still unacceptable, then remake calibration standards or use new primary standards and recalibrate instrument.
Continuing Calibration Standards *(Analyst, Data Reviewer)*	% Recovery within control limits.	- Reanalyze standard. - If still unacceptable, then recalibrate and rerun affected samples.
Matrix Spike / Matrix Spike Duplicate (MS/MSD) *(Analyst, Data Reviewer)*	- % Recovery within limits documented in TALS and/or Work Instructions	- 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.
Laboratory Control Sample (LCS) *(Analyst, Data Reviewer)*	- % Recovery within limits specified in TALS and/or Work Instructions	- Batch must be re-prepared and re-analyzed. **Note:** If there is insufficient sample or the holding time cannot be met, contact client and report with flags.
Surrogates *(Analyst, Data Reviewer)*	- % Recovery within limits of method or within three standard deviations of the historical mean.	- Individual sample must be repeated. Place comment in LIMS.
Method Blank (MB_ *(Analyst, Data Reviewer)*	< Reporting Limit [1]	- Reanalyze blank. - If still positive, determine source of contamination. If necessary, reprocess (i.e. digest or extract) entire sample batch. Report blank results.

QC Activity ***(Individual Responsible for Initiation/Assessment)***	**Acceptance Criteria**	**Recommended Corrective Action**
Proficiency Testing (PT) Samples *(QA Manager, Department Manager/Supervisor)*	- 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.
Internal / External Audits *(QA Manager, Department Manager/Supervisor, Laboratory Director/Manager)*	- 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, Department Manager/ Supervisor, QA Manager, Corporate QA, Corporate Management)	- SOP CA-L-S-001, Internal Investigation of Potential Data Discrepancies and Determination for Data Recall.	- Corrective action is determined by type of error. Follow the procedures in SOP CA-L-S-001 or the Corrective Action SOP (ED-GEN-003).
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 17 for an example) (QA Manager, Lab Director/Manager, Department Supervisors/Managers)	- QAM, SOPs.	- Corrective action is determined by the type of issue. For example, CARs for the month are reviewed and possible trends are investigated.

QC Activity *(Individual Responsible for Initiation/Assessment)*	Acceptance Criteria	Recommended Corrective Action
Health and Safety Violation (Safety Officer, Lab Director/Manager, Department Supervisor/Manager)	- Environmental Health and Safety (EHS) Manual.	- Non-conformance is investigated and corrected through CAR system.

Note:

1. Except as noted below for certain compounds, the method blank should be below the detection limit. Concentrations up to five times the reporting limit will be allowed for the ubiquitous laboratory and reagent contaminants: methylene chloride, toluene, acetone, 2-butanone and phthalates **provided** they appear in similar levels in the reagent blank and samples. This allowance presumes that the detection limit is significantly below any regulatory limit to which the data are to be compared and that blank subtraction will not occur. For benzene and ethylene dibromide (EDB) and other analytes for which regulatory limits are extremely close to the detection limit, the method blank must be below the method detection limit

SECTION 14

PREVENTIVE ACTION *(NELAC 5.4.11)*

14.1 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 continuous process improvement activity 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 satisfaction can be improved through continuous improvements to laboratory systems.

Opportunities for improvement may be discovered during management reviews, the QA Metrics Report, internal or external audits, proficiency testing performance, client complaints, staff observation, etc..

The monthly QA Metrics Report shows performance indicators in all areas of the 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 to help evaluate 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.

14.1.1 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.

14.1.2 Any Preventive Actions undertaken or attempted shall be taken into account during the Annual Management Review (Section 16). A highly detailed recap is not required; a simple

recount of success and failure within the preventive action program will provide management a measure for evaluation.

14.2 MANAGEMENT OF CHANGE

The Management of Change process is designed to manage significant events and changes that occur within the laboratory. Through these various tracking indicators, the potential risks inherent with a new event or change are identified and evaluated. The risks are minimized or eliminated through pre-planning and the development of preventive measures. The types of indicators monitored under this collective system include:

- SOP Tracking
  Current Revisions w/ Effective Dates
  Required Biennial Revisions w/ Due Date

- Proficiency Testing (PT) Sample Tracking
  Pass / Fail – most current 2 out of 3 studies.

- Instrument / Equipment List
  Current / Location

- Accreditations
  New / Expiring

- Method Capabilities
  Current Listing by program (e.g., Potable Water, Soils, etc.)

- Key Personnel
  Technical Managers, Department Supervisors, etc..

These items are maintained on TestAmerica's Intranet (Proposal Library) or on our internal database (TotalAccess) which uploads to our company internet site.

SECTION 15

CONTROL OF RECORDS *(NELAC 5.4.12)*

The laboratory maintains a record 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.

15.1 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 15-1. Quality records (QA records) are maintained by the QA department and are indexed in a database, which is backed up as part of the regular laboratory backup. Records are of two types; either electronic or hard copy paper formats depending on whether the record is computer or hand generated (some records may be in both formats). Technical records are maintained by Laboratory Operations under the direction of the Laboratory Operations Manager.

Table 15-1. Record Index[1]

	Record Types [1]:	Retention Time:
Technical Records	- Raw Data - Logbooks[2] - Standards - Certificates - Analytical Records - Lab Reports	5 Years from analytical report issue*
Official Documents	- Quality Assurance Manual (QAM) - Work Instructions - Policies - SOPs - Manuals	5 Years from document retirement date*
QA Records	- Internal & External Audits/Responses - Certifications - Corrective/Preventive Actions - Management Reviews - Method & Software Validation / Verification Data - Data Investigation	5 Years from archival* **Data Investigation:** 5 years or the life of the affected raw data storage whichever is greater (beyond 5 years if ongoing project or pending investigation)
Project Records	- Sample Receipt & COC Documentation - Contracts and Amendments - Correspondence - QAPP -SAP - Telephone Logbooks - Lab Reports	5 Years from analytical report issue*

	Record Types [1]:	Retention Time:
Administrative Records	Finance and Accounting	10 years
	EH&S Manual, Permits, Disposal Records	7 years
	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 15-2.

All records are stored and retained in such a way that they are secure and readily retrievable at the laboratory facility or a secure 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. Records archived off-site are stored in a secure location where a record is maintained of any entry into the storage facility. Whether on-site or off-site storage is used, logs are maintained in each storage box to note removal and return of records. 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 15-2 have lengthier retention requirements and are subject to the requirements in Section 15.1.3.

15.1.1 Programs with Longer Retention Requirements

Some regulatory programs have longer record retention requirements than the standard record retention time. These are detailed in Table 15-2 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 15-2. Example: Special Record Retention Requirements

Program	[1]Retention Requirement
Drinking Water – All States	10 years (project records)
Drinking Water Lead and Copper Rule	12 years (project records)
NY Potable Water NYCRR Part 55-2	10 years

[1]Note: Extended retention requirements must be noted with the archive documents or addressed in facility-specific records retention procedures.

15.1.2 The laboratory has procedures to protect and back-up records stored electronically and to prevent unauthorized access to or amendment of these records. All analytical data is maintained as hard copy or in a secure readable electronic format. For analytical reports that are maintained as copies in PDF format, refer to TestAmerica Edison SOP No. ED-GEN-024 (Record Storage and Retention).

15.1.3 The record keeping system allows for historical reconstruction of all laboratory activities that produced the analytical data, as well as rapid recovery of historical data. 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. The laboratory's copy of the chain of custody is stored in the laboratory's hard copy project file (in addition to the scanned copy included in the analytical report PDF). The chain of custody would indicate the name of the sampler. If any sampling notes are provided with a work order, they are kept in the project file as well. For additional details please refer to refer to TestAmerica Edison SOP No. ED-GEN-024 (Record Storage and Retention).

- 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 purposes (e.g., set format for naming electronic files, set format for what is included with a given analytical data set. Reference TestAmerica Edison SOP No. ED-GEN-024 (Record Storage and Retention).

- Instrument data is stored sequentially by instrument. A given day's analyses are maintained in the order of the analysis. Run logs are maintained for each instrument or method; a copy of each day's run long or instrument sequence is stored with the data to aid in re-constructing an analytical sequence. Where an analysis is performed without an instrument, bound logbooks or bench sheets are used to record and file data. Standard and reagent information is recorded in logbooks or entered into the LIMS for each method as required.

- Changes to hardcopy records shall follow the procedures outlined in Section 13 and 20. 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 20.14.1 'Computer and Electronic Data Related Requirements'.

15.2 TECHNICAL AND ANALYTICAL RECORDS

15.2.1 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. The records shall include the identity of laboratory personnel responsible for the sampling, performance of each analysis and reviewing results.

15.2.2 Observations, data and calculations are recorded real-time and are identifiable to the specific task.

15.2.3 Changes to hardcopy records shall follow the procedures outlined in Section 13 and 20. 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. Operating conditions/parameters are typically recorded in instrument maintenance logs where available.
- analysis type;
- all manual calculations and manual integrations;
- analyst's or operator's initials/signature;

- sample preparation including cleanup, separation protocols, incubation periods or subculture, ID codes, volumes, weights, instrument printouts, meter readings, calculations, reagents;
- 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. These are indicated both in the LIMS and on specific analytical report formats.

15.3 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

15.3.1 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.

15.4 ADMINISTRATIVE RECORDS

The laboratory also maintains the administrative records in either electronic or hard copy form. Refer to Table 15-1.

15.5 RECORDS MANAGEMENT, STORAGE AND DISPOSAL

15.5.1 All records (including those pertaining to test equipment), certificates and reports are safely stored, held secure and in confidence to the client. Certification related records are available upon request.

15.5.2 All information necessary for the historical reconstruction of data is maintained by the laboratory. Records that are stored only on electronic media must be supported by the hardware and software necessary for their retrieval.

15.5.3 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.

15.5.4 The laboratory has a records management system for control of laboratory notebooks, instrument logbooks, standards logbooks, and records for data reduction, validation, storage and reporting. Laboratory notebooks are issued on a per analysis basis, and are numbered sequentially. All data are recorded sequentially within a series of sequential notebooks. Bench sheets are filed sequentially. Records are considered archived when noted as such in the records management system.

15.5.5 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.

15.5.6 Records Disposal

15.5.6.1 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 15-1 and 15-2).

15.5.6.2 Electronic copies of records must be destroyed by erasure or physically damaging

off-line storage media so no records can be read.

15.5.6.3 If a third party records Management Company is hired to dispose of records, a "Certificate of Destruction" is required.

SECTION 16

AUDITS *(NELAC 5.4.13)*

16.1 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 Audits, SOP No. CA-Q-S-004. The types and frequency of routine internal audits are shown in Table 16-1. Special or ad hoc assessments may be conducted as needed under the direction of the QA staff.

Table 16-1. Types of Internal Audits and Frequency

Description	Performed by	Frequency
Quality Systems	QA Department or Designee	All areas of the laboratory annually
QA Technical Audits - Evaluate raw data versus final reports - Analyst integrity - Data authenticity	QA Department or Designee	All methods within a 2-year period, with at least 15% of methods every quarter
SOP Method Compliance	Technical Director	- All SOPs within a 2-year period - All new analysts or new analyst/methods within 3 months of IDOC
Special	QA Department or Designee	Surveillance or spot checks performed as needed
Performance Testing	Analysts with QA oversight	Two successful per year for each NELAC field of testing or as dictated by regulatory requirements

16.1.1 Annual Quality Systems Audit

An annual quality systems audit is required to ensure compliance to analytical methods and SOPs, the laboratory's Data Integrity and Ethics Policies, NELAC quality systems, client and state requirements, and the effectiveness of the internal controls of the analytical process, including but not limited to data review, quality controls, preventive action and corrective action. The completeness of earlier corrective actions is assessed. The audit is divided into modules for each operating or support area of the lab, and each module is comprehensive for a given

area. The area audits may be done on a rotating schedule throughout the year to ensure adequate coverage of all areas. This schedule may change as situations in the laboratory warrant.

16.1.2 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, MintMiner is used to identify unusual manipulations of the data deserving closer scrutiny. QA technical audits will include all methods within a two-year period.

16.1.3 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 Technical Director at least every two years. The work of each newly hired analyst is assessed within 3 months of working independently, (e.g., completion of method IDOC). In addition, as analysts add methods to their capabilities, (new IDOC) reviews of the analyst work products will be performed within 3 months of completing the documented training.

16.1.4 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.

16.1.5 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: Drinking Water, Non-potable Water, Soil and Hazardous Waste.

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.

16.2 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. 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.

16.2.1 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 within the 2003 NELAC standards.

16.3 AUDIT FINDINGS

Audit findings are documented using the corrective action process and database. The laboratory's corrective action responses for both types of audits may include action plans that could not be completed within a predefined timeframe. In these instances, a completion date must set and agreed to by operations management and 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. . 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 17

MANAGEMENT REVIEWS *(NELAC 5.4.14)*

17.1 QUALITY ASSURANCE REPORT

A comprehensive QA Report shall be prepared each month by the laboratory's QA Department and forwarded to the Laboratory Director, Operations Manager, 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.

17.2 ANNUAL MANAGEMENT REVIEW

The senior lab management team (Laboratory Director 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 quality goals & objectives. Corporate Operations and Corporate QA personnel is be included in this meeting at the discretion of the Laboratory Director. The LIMS review consists of examining any audits, complaints or concerns that have been raised through the years 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 review (Corporate 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.

17.3 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. CA-L-S-001). 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 18

PERSONNEL *(NELAC 5.5.2)*

18.1 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.

18.2 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 (Also see Section 4 for position descriptions/responsibilities).

Experience and specialized training are occasionally accepted in lieu of a college degree (basic lab skills such as using a balance, colony counting, aseptic or quantitation techniques, etc., are also considered).

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
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
Technical Directors/Department Managers – **General**	Bachelors Degree in an applied science or engineering with 24 semester hours in chemistry An advanced (MS, PhD.) degree may substitute for one year of experience	And 2 years experience in environmental analysis of representative analytes for which they will oversee
Technical Director/ Department Managers – **Wet Chem** only (no advanced instrumentation)	Associates degree in an applied science or engineering or 2 years of college with 16 semester hours in chemistry	And 2 years relevant experience

When an analyst does not meet these requirements, they can perform a task under the direct supervision of a qualified analyst, peer reviewer or Department Manager, and are considered an analyst in training. The person supervising an analyst in training is accountable for the quality of the analytical data and must review and approve data and associated corrective actions.

18.3 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 20.

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 20).
- 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.

Further details of the laboratory's training program are described in the Laboratory Training SOP (TestAmerica Edison SOP No. ED-GEN-022).

18.4 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, 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. CA-L-P-001) 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.
- Record keeping.
- 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 19

ACCOMMODATIONS AND ENVIRONMENTAL CONDITIONS *(NELAC 5.5.3)*

19.1 OVERVIEW

The laboratory is a 42,000 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.

19.2 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. Such environmental conditions include humidity and temperature levels in the laboratory (when appropriate).

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.

19.3 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.

19.4 FLOOR PLAN

A floor plan can be found in Appendix 1.

19.5 BUILDING SECURITY

Building keys 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.

SECTION 20

TEST METHODS AND METHOD VALIDATION *(NELAC 5.5.4)*

20.1 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.

20.2 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 (annually for Drinking Water and DoD SOPs), and where necessary, revised to ensure continuing suitability and compliance with applicable requirements.

20.3 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.

20.4 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.

20.4.1 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:

- *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*

- *Statement of Work for Inorganics Analysis, ILM04.1, USEPA Contract Laboratory Program Multi-media, Multi-concentration.*
- *Statement of Work for Organics Analysis, OLM04.2, USEPA Contract Laboratory Program, Multi-media, Multi-concentration.*
- *Statement of Work for Organic Analysis, Multi-Media, Multi-Concentration, OLMO4.1, USEPA Contract Laboratory Program, September 1998.*
- *Standard Methods for the Examination of Water and Wastewater, 18th/19th /20th 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.*
- *Annual Book of ASTM Standards, American Society for Testing & Materials (ASTM), Philadelphia, PA.*
- *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.

20.4.2 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.

20.4.2.1 A demonstration of capability (DOC) (reference TestAmerica Edison Training SOP No. ED-GEN-022) is performed whenever there is a change in instrument type (e.g., new instrumentation), method or personnel.

20.4.2.2 The initial demonstration of capability must be thoroughly documented and approved by the Department Manager and QA Manager prior to independently analyzing client samples. All associated documentation must be retained in accordance with the laboratories archiving procedures.

20.4.2.3 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 20.6.1.3, 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.*

20.4.3 <u>Initial Demonstration of Capability (IDOC) Procedures</u>

20.4.3.1 The spiking standard used must be prepared independently from those used in instrument calibration.

20.4.3.2 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.

20.4.3.3 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).

20.4.3.4 Using all of the results, calculate the mean recovery in the appropriate reporting units and the standard deviations for each parameter of interest.

20.4.3.5 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.

20.4.3.6 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.

20.4.3.7 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 20.4.3.3 above.
- Beginning with 20.4.3.3 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 20.4.3.1 above.

Note: Results of successive LCS analyses can be used to fulfill the DOC requirement.

A certification statement (refer to Figure 20-1 for 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.

Methods on line prior to the effective date of this Section shall be updated to the procedures outlined above as new analysts perform their demonstration of capability. A copy of the new record will replace that which was used for documentation in the past. At a minimum, the precision and accuracy of four mid-level laboratory control samples must have been compared to the laboratory's quality control acceptance limits.

20.5 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.

20.6 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.

20.6.1 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.

20.6.1.1 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.

20.6.1.2 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.

20.6.1.3 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.

20.6.1.4 Determination of Interferences

A determination that the method is free from interferences in a blank matrix is performed.

20.6.1.5 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.

20.6.1.6 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.

20.6.1.7 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.

20.6.1.8 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.

20.7 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 (refer to 19.7.10). Generally, the analyst prepares at least seven replicates of solution spiked at one to five times the estimated method detection limit (most often at the lowest standard in the calibration curve) into the applicable matrix with all the analytes of interest. Each of these aliquots is extracted (including any applicable clean-up procedures) and analyzed in the same manner as the samples. Where possible, the seven replicates should be analyzed over 2-4 days to provide a more realistic MDL. [To allow for some flexibility, this low level standard may be analyzed every batch or every week or some other frequency rather than doing the study all at once. In addition, a larger number of data points may be used if the appropriate t-value multiplier is used]

Refer to the Corporate SOP No. CA-Q-S-006 for details on the laboratory's MDL process.

20.8 INSTRUMENT DETECTION LIMITS (IDL)

20.8.1 The IDL is sometimes used to assess the reasonableness of the MDLs or in some cases required by the analytical method or program requirements. IDLs are most used in metals analyses but may be useful in demonstration of instrument performance in other areas.

20.8.2 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.

20.8.3 If IDL is > than the MDL, it may be used as the reported MDL.

20.9 VERIFICATION OF DETECTION AND REPORTING LIMITS

20.9.1 Once an MDL is established, it must be verified, on each instrument, by analyzing a quality control sample (prepared as a sample) at approximately 2-3 times the calculated MDL for single analyte analyses (e.g. most wet chemistry methods, Atomic Absorption, etc.) and 1-4 times the calculated MDL for multiple analyte methods (e.g. GC, GCMS, ICP, etc.). The analytes must be qualitatively identified. This verification does 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 MDL does not verify, then the lab will not report to the MDL, or redevelop their MDL or use the level where qualitative identification is established. MDLs must be verified at least annually.

20.9.2 When the laboratory establishes a quantitation limit, it must be initially verified by the analysis of a low level standard or QC sample at 1-2 the reporting limit and annually thereafter. The annual requirement is waved for methods that have an annually verified MDL. The laboratory will comply with any regulatory requirements.

20.10 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. These records are kept with the files associated with an instrument for later quantitation of the analytes. Complete details are available in the laboratory SOPs.

20.11 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.

20.12 ESTIMATION OF UNCERTAINTY OF MEASUREMENT

20.12.1 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.

20.12.2 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.

20.12.3 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.

20.12.4 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.

20.12.5 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.

20.13 SAMPLE REANALYSIS GUIDELINES

Because there is a certain level of uncertainty with any analytical measurement, a sample reanalysis may result in either a higher or lower value from an initial sample analysis. There are also may be variables present (e.g., sample homogeneity, analyte precipitation over time, etc.) that affect the results of a reanalysis. Bearing these factors in mind, the laboratory will reanalyze samples at a client's request with the following caveats. (Note: Client specific Contractual Terms & Conditions for reanalysis protocols may supercede 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 $\pm$ 1 reporting limit for samples $\leq$ 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 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.

- Due to the potential for increased variability, reanalysis may not be applicable to Non-homogenous, Encore, and Sodium Bisulfate preserved samples. See the Laboratory Director if unsure.

20.14 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.

20.14.1 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 TestAmerica Edison SOPs No. ED-GEN-001 (Data Management and Handling Procedures) and ED-GEN-002 (Document Control). The laboratory is currently running the TALS LIMS which is a in-house developed LIMS system that has been highly customized to meet the needs of the laboratory. It is referred to as LIMS for the remainder of this section. The LIMS utilizes Microsoft SQL Server which is an industry standard relational database platform. It is referred to as Database for the remainder of this section.

20.14.1.1 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.

20.14.1.2 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.

20.14.1.3 Maintain Confidentiality: Ensure data confidentiality through physical access controls, and encryption of when electronically transmitting data.

20.14.2 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.

For manual data entry, e.g., Wet Chemistry, the data is reduced by the analyst and then verified by the Department Manager or alternate analyst prior to updating the data in LIMS. The spreadsheets, or any other type of applicable documents, are signed by both the analyst and alternate reviewer to confirm the accuracy of the manual entry(s).

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*.

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.

20.14.2.1 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.

20.14.2.2 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.

20.14.2.3 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 2 significant figures on the final report.

20.14.2.4 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.

20.14.2.5 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 folder on the instrument computer; periodically, this file is transferred to the server and, eventually, to a tape file.

20.14.3 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 13.
- 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 Department Manager/QA Manager at the facility. The QA Manager controls all worksheets following the procedures in Section 6.

20.14.4 Review / Verification Procedures

Review procedures are out lined in several SOPs (including but not limited to, TestAmerica Edison SOP Nos. ED-GEN-021: Data Review, ED-SPM-001:Login, and ED-RP-001:Reports Production) 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 general review concepts are discussed below, more specific information can be found in the SOPs.

20.14.4.1 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.

20.14.4.2 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 or Department Manager/Supervisor 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, continuing calibration results, laboratory control samples, sample data, qualifiers and spike information are evaluated. Manual integrations are also electronically reviewed periodically by the QA Department 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

20.14.4.3 Unacceptable analytical results may require reanalysis of the samples. Any problems are brought to the attention of the Laboratory Director, Project Manager, Quality Assurance Manager, Laboratory Operations Manager, or Department Manager for further investigation. Corrective action is initiated whenever necessary.

20.14.4.4 The results are then entered or directly transferred into the computer database and a hard copy (or .pdf) is printed for the client.

20.14.4.5 As a final review prior to the release of the report, the Project Manager reviews the results for appropriateness and 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, chain of custody is followed, cover letters/ narratives are present, flags are appropriate, and project specific requirements are met.

20.14.4.6 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.

20.14.5 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).

20.14.5.1 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.

20.14.5.2 Analysts shall not increase or decrease peak areas to 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.

20.14.5.3 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.

20.14.5.4 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 20-1.
Example - Demonstration of Capability Documentation

DEMONSTRATION OF CAPABILITIY (DOC)

Laboratory Name:_____
Laboratory Address:_____
Method:_____ Matrix:_____
Date:_____ Analyst(s):_____
Source of Analyte(s):_____

Analytical Results

Analyst	Conc. (Units)	Rep 1	Rep 2	Rep 3	Rep 4	Avg. % Recovery	% RSD
_____	_____	_____	_____	_____	_____	_____	_____

% RSD = Percent relative standard deviation = standard deviation divided by average % Recovery

Raw data reference: _____

Certification Statement:

We, the undersigned, certify that:
1. The cited test method has met Demonstration of Capability requirements.
2. The test method was performed by the analyst(s) identified on this certification.
3. A copy of the test method and the laboratory-specific SOPs are available for all personnel on site.
4. The data associated with the method 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, and the associated information is well organized and available for review.
6.

_____ _____
Analyst Signature Date

_____ _____
Technical Director Signature Date

_____ _____
Quality Assurance Coordinator Signature Date

SECTION 21

EQUIPMENT (AND CALIBRATIONS) *(NELAC 5.5.5)*

21.1 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. An example laboratory equipment list is presented in Table 21-1. The most current list of laboratory instrumentation can be found in TestAmerica Edison Work Instruction No. ED-WI-002 (Equipment Inventory)

Equipment is only operated by authorized and trained personnel. Manufacturers instructions for equipment use are readily accessible to all appropriate laboratory personnel.

21.2 PREVENTIVE MAINTENANCE

21.2.1 The laboratory follows a well-defined maintenance program to ensure proper equipment operation and to prevent the failure of laboratory equipment or instrumentation during use. This program of preventive maintenance helps to avoid delays due to instrument failure.

21.2.2 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.

21.2.3 Table 21-2 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 also be outlined in analytical SOPs or instrument manuals. (Note: for some equipment, the log used to monitor performance is also the maintenance log. Multiple pieces of equipment may share the same log as long as it is clear as to which instrument is associated with an entry.)

21.2.4 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.

21.2.4.1 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.

21.2.4.2 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.

21.2.4.3 When maintenance or repair is performed by an outside agency, service receipts detailing the service performed may be affixed into the logbooks adjacent to pages describing the maintenance performed or filed in the Department Managers office If stapled into the logbook the 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.

21.2.5 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.

21.2.6 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.

21.2.7 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.

21.3 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.

21.3.1 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.

21.3.2 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.

21.3.3 Thermometers

All thermometers are calibrated on an annual basis with a NIST-traceable thermometer. IR thermometers, digital probes and thermocouples are calibrated quarterly.

The 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 method-specific logbooks. More information on this subject can be found in the laboratory SOP No. ED-GEN-014 (Thermometer Calibration).

21.3.4 Refrigerators/Freezer Units, Waterbaths, Ovens and Incubators

The temperatures of all refrigerator units and freezers used for sample and standard storage are monitored each working 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 > 0°C and ≤ 6 °C.

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 Daily Temperature Logbooks and method-specific logbooks.

21.3.5 Autopipettors, Dilutors, and Syringes

Mechanical volumetric dispensing devices including burettes (except Class A Glassware) are given unique identification numbers and the delivery volumes are verified gravimetrically, at a minimum, on a quarterly basis. Glass micro-syringes are considered the same as Class A glassware.

For those dispensers that are not used for analytical measurements, a label can be applied to the device stating that it is not calibrated. Any device not regularly verified can not be used for any quantitative measurements. Refer to TestAmerica Edison SOP No. ED-GEN-011 (Calibration and Use of Lab Pippettes).

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.

21.3.6 Autoclaves

The laboratory utilizes autoclaves in the sample preparation step for certain mercury analysis procedures. These autoclaves have direct reading temperature and pressure gauges. These gauges are checked for accuracy on an annual basis.

21.3.7 Field Sampling Devices (Isco Auto Samplers)

Each Auto Sampler (ISCO) is assigned a unique identification number in order to keep track of the calibration. This number is also recorded on the sampling documentation.

The Auto Sampler is calibrated as needed based on manufacturers recommendations.

21.4 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 13).

Note: Instruments are calibrated initially and as needed after that and at least annually.

21.4.1 CALIBRATION STANDARDS

21.4.1.1 Calibration standards are prepared using the procedures indicated in the Reagents and Standards section of the determinative method SOP.

21.4.1.2 Standards for instrument calibration are obtained from a variety of sources. All standards are traceable to national or international standards of measurement, or to national or international standard reference materials.

21.4.1.3 The lowest concentration calibration standard that is analyzed during an initial calibration must be at or below the stated reporting limit for the method based on the final volume of extract (or sample).

21.4.1.4 All initial calibrations are verified with a standard obtained from a second source and traceable to a national standard, when available (or vendor certified different lot if a second source is not available). For unique situations, such as air analysis where no other source or lot is available, a standard made by a different analyst would be considered a second source. This verification occurs immediately after the calibration curve has been analyzed, and before the analysis of any samples.

21.4.2 Calibration Verification

The calibration relationship established during the initial calibration must be verified at least daily as specified in the laboratory method SOPs in accordance with the referenced analytical methods and NELAC (2003) standard, Section 5.5.5.10. 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.

Note: The process of calibration verification referred to is fundamentally different from the approach called "calibration" in some methods. As described in those methods, the calibration factors or response factors calculated during calibration are used to update the calibration factors or response factors used for sample quantitation. This approach, while employed in other EPA programs, amounts to a daily single-point calibration.

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.

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).

21.4.2.1 Verification of 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.

21.4.2.2 Verification of a Non-Linear Calibration

Calibration verification of a non-linear calibration is performed using the percent drift or percent recovery calculations.

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.

21.5 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.

21.6 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 21-1. Example: Laboratory Instrumentation List

Instrument Type	Manufacturer	Model	Purchase Date	Install Date	Autosampler	Method Performed
METALS						
ICP	Thermo Jarrell Ash (1) S/N 341490	61E Trace	1994	Dec94	Yes	6010B, 200.7, CLP
	Thermo Jarrell Ash (2) S/N 356490	61E Trace	1998	Feb98	Yes	6010B, 200.7, CLP
	Thermo Jarrell Ash (3) S/N 493890	61E Trace	2000	Sep00	Yes	6010B, 200.7, CLP
	Thermo Jarrell Ash (4) S/N: ICP-20073407	ICAP 6500 Duo View	2007	TBD	Yew	6010B, 200.7, CLP
ICP-MS ICPMS Heat Exchanger Autosampler	Agilent Technologies S/N JP51201560 PolyScience S/N G57335 Cetac S/N 120536A520	7500ce 3370 ASX520	2006	May06	Yes	6020A, 200.8
Mercury Analyzer	Leeman Labs (3) S/N HA-3010	Hydra AA	2003	Jan04	Yes	7471A, 7470, 245.1 CLP
	Leeman Labs (4) S/N HA-4008	Hydra AA	2004	Jun04	Yes	7471A, 7470, 245.1 CLP
Hotblock 1	Environmental Express Limited S/N 2772CEC1378	SC154	2003	2003	No	3050B, CLP
Hotblock 2	Environmental Express Limited S/N 2391CEC1273	SC154	2004	2004	No	3050B, CLP
Autoclave (Out of Service)	Steril-Matic S/N 95-2678	MEA 109-85-E	1996	1996	No	7471A
Hot Plate 1 (Out of Service)	Fischer Scientific S/N 1000132		Jan04	Jan04	No	200.7, 3010A, 3020A, CLP
Hot Plate 2 (Out of Service)	Fischer Scientific S/N 1000153		Oct04	Oct04	No	200.7, 3010A, 3020A, CLP
Hot Plate 3 (Out of Service)	Fischer Scientific S/N 1000168		Jul03	Jul03	No	200.7, 3010A, 3020A, CLP
Hot Plate 4 (Out of Service)	Fischer Scientific S/N 1000169		May05	May05	No	200.7, 3010A, 3020A, CLP
Hot Plate 5 (Out of Service)	Fischer Scientific S/N 1000170		Apr05	Apr05	No	200.7, 3010A, 3020A, CLP
Hot Plate 6 (Out of Service)	Fischer Scientific S/N 1000203		Dec04	Dec04	No	200.7, 3010A, 3020A, CLP
Hot Plate 7 (Out of Service)	Fischer Scientific S/N 1000210		Apr05	Apr05	No	200.7, 3010A, 3020A, CLP
Hot Plate 8 (Out of Service)	Fischer Scientific S/N 1000220		Jun05	Jun05	No	200.7, 3010A, 3020A, CLP
Hotblock 3	Environmental Express Limited S/N 4298CEC2048	SC150	2004	2004	No	200.7, 3010A, 200.8, CLP
Hotblock 4	Environmental Express Limited S/N 4507CEC2115	SC150	2006	2006	No	200.7, 3010A, 200.8, CLP

Table 21-1. Example: Laboratory Instrumentation List

Instrument Type	Manufacturer	Model	Purchase Date	Install Date	Autosampler	Method Performed
Hotblock 5	Environmental Express Limited S/N 4667CEC2183	SC150	2006	2006	No	200.7, 3010A, 200.8, CLP
Hotblock 6	Environmental Express Limited S/N 4667CEC2183	SC150	2006	2006	No	200.7, 3010A, 200.8, CLP
Hotblock 7	Environmental Express Limited S/N 2772CDC1378	SC150	2006	2006	No	200.7, 3010A, 200.8, CLP
Balance # 35	Acculab 18255989		2005	2005	No	3050B, CLP
Balance # 33	Ohaus F0461200521139		2001	2001	No	7471A
Autoclave	Steril-Matic S/N 201188	STME	2002	2002	No	7471A
GC/MS Semivolatiles (BNAMS1/GC) GC MS Tower Tray Controller	Hewlett-Packard S/N 3223A43511 S/N 3118A02442 S/N 3013A21967 S/N 3249A30680 S/N 3249A30674	5971 7673	1986	1986	Yes	8270C, 625
(BNAMS2/GC) GC MS Tower Tray Controller	Hewlett-Packard S/N 2618A07933 S/N 3234A04110 S/N 2704A08901 S/N 2718A08680 S/N 2607A02892	5971 7673A	1986	1986	Yes	8270C, 625, CLP
(BNAMS3/GC) GC MS Tower Tray Controller	Hewlett-Packard S/N 3140A38366 S/N 3188A02926 S/N 3266A31274 S/N 3021A21499 S/N 3138A27180	5971 7673	1986	1986	Yes	8270C, 625, CLP
(BNAMS4/GC) GC MS Tower Tray Controller	Hewlett-Packard S/N 3108A34490 S/N 3114A02077 S/N 2546A02861 S/N 2942A20598 S/N 2803A11211	5971A 7673A	1986	1986	Yes	8270C, 625, CLP
(BNAMS5/GC) GC MS Tower Tray Controller	Agilent Technologies S/N CN10726100 S/N US35120328 S/N CN72441261 S/N CN40427800 S/N CN40427800	5975C 7890A	2007	2007	Yes	8270C, 625, CLP

Table 21-1. Example: Laboratory Instrumentation List

Instrument Type	Manufacturer	Model	Purchase Date	Install Date	Autosampler	Method Performed
(BNAMS6/GC)	Hewlett-Packard		1990	1990	Yes	8270C, 625, CLP
GC	S/N 3336A54722					
MS	S/N 3234A04274	5971				
Tower	S/N 2843A13155	7673				
Tray	S/N 2933A11253					
Controller	S/N 3018A21811					
(BNAMS7/GC)	Hewlett-Packard		1990	1990	Yes	8270C, 625, CLP
GC	S/N 3235A45833					
MS	S/N 3307A00368	5972				
Tower	S/N 2546602130	7673A				
Tray	S/N 2633A02968					
Controller	S/N 2511A01985					
(BNAMS8/GC)	Hewlett-Packard		1990	1990	Yes	8270C, 625, CLP
GC	S/N 336A56444					
MS	S/N 3435A01857	5972				
Tower	S/N C11144007149	A0C-20i				
Tray	S/N C11154103496					
Controller	S/N 626059SA					
(BNAMS9/GC)	Agilent Technologies		2004	2004	Yes	8270C, 625, CLP
GC	S/N CN10349071					
MS	S/N US35120328	5973				
Tower	S/N CN35134357	7683				
Tray	S/N CN40427800					
Controller	S/N CN40427800					
(BNAMS10/GC)	Agilent Technologies		2004	2004	Yes	8270C, 625, CLP
GC	S/N CN10403063					
MS	S/N US35120373	5973				
Tower	S/N CN40334758	7683				
Tray	S/N CN40327770					
Controller	S/N CN40327770					
(BNAMS11/GC)	Agilent Technologies		2007	2007	Yes	8270C, 625, CLP
GC	S/N CN10727109					
MS	S/N US71236621	5975C				
Tower	S/N CN35134357	7890A				
Tray	S/N CN72441255					
Controller						
BNAGC2	Hewlett-Packard		1986	1986	Yes	Screen
GC	S/N 3336A55994	5890 II				
Tower 1	S/N 3004A20530	7673				
Tower 2	S/N 3613A21129					
Tray	S/N 3021A21938					
Controller	S/N 3244A30371					

Table 21-1. Example: Laboratory Instrumentation List

Instrument Type	Manufacturer	Model	Purchase Date	Install Date	Autosampler	Method Performed
BNAGC8	Hewlett-Packard		1986	1986	Yes	Screen
GC	S/N 3121A35833	5890				
Tower 1	S/N 2704805765	7673A				
Tray	S/N 3131A25914					
Controller	S/N 2921A03449					
Manifold			10/29/04	11/1/04	No	
Gases	Western Enterprise 28452	Innovator HBAC2-5-4				
GC/MS Volatiles					Yes	8260, 624, CLP, 524.2
	Agilent	5975	Feb06	Jul06		
VOAMS1	S/N US60532504					
	Agilent	6890N	Feb06	Jul06		
GC	S/N CN10606023					
	OI	4551A	Feb06	Jul06		
Autosampler	S/N D60345B194					
	OI	4660	Feb06	Jul06		
Concentrator	S/N D608466853					
	OI	SAM	Feb06	Jul06		
Spiker	S/N E610475713					
VOAMS2	Hewlett-Packard	5975C	2008	2008	Yes	8260, 624, CLP,
	S/N US80838709					
GC	Hewlett-Packard	7890A	2008	2008		
	S/N CN10813013					
Autosampler	EST	Archon 51	2008	2008		
	S/N 15264					
Concentrator	EST	Encon Evolution	2008	2008		
	S/N 104041408					
VOAMS3	Agilent	5973inert	Feb04	Aug04	Yes	8260B, 624, CLP, 524.2
	S/N US35120382					
GC	Agilent	6890N	Feb04	Aug04		
	S/N CN10406105					
Autosampler	EST	Centurion	Jun04	Aug04		
	S/N CENT140051304					
Concentrator A	EST	Encon	May04	Aug04		
	S/N 367060704					
Concentrator B	EST	Encon	May04	Aug04		
	S/N 368060704					

Table 21-1. Example: Laboratory Instrumentation List

Instrument Type	Manufacturer	Model	Purchase Date	Install Date	Autosampler	Method Performed
VOAMS4	Hewlett-Packard S/N US80838712	5975C	2008	2008	Yes	8260, 624, CLP,
GC	Hewlett-Packard S/N CN10813014	7890A	2008	2008		
Autosampler 1	OI S/N 15266	4552	2008	2008		
Concentrator	OI S/N D809466076	2008	2008	2008		
VOAMS5	Hewlett-Packard S/N 3234A04198	5971	1996	1996	Yes	8260B, 624, CLP, 524.2
GC	Hewlett-Packard S/N 3033A33368	5890 II	1996	1996		
Autosampler	Archon S/N 11957-696A	5100A	1996	1996		
Concentrator	OI S/N D310219	4560	1996	1996		
VOAMS6	Agilent VOAMS6 S/N US35120322	5973inert	Feb04	Apr04	Yes	624, 524.2, CLP
GC	Agilent S/N CN10406076	6890N	Feb04	Apr04		
Autosampler	OI S/N D54645B461	4551A	Nov05	Dec05		
Concentrator	OI S/N D548466579	4660	Nov05	Dec05		
Spiker	OI S/N C425475656	SAM	Jun04	Jul04		
VOAMS7	Agilent S/N US43110514	5973inert	Oct 04	Nov 04	Yes	624, 524.2,8260 CLP
GC	Agilent S/N CN10437064	6890N	Oct 04	May 06		
Autosampler	Teledyne Tekmar S/N US08121007	Solatek	Tekmar swap	May 08		
Concentrator	Teledyne Tekmar S/N US08007007	Stratum	Tekmar swap	May 08		
VOAMS8	Hewlett-Packard S/N 3118A02630	5971	1998	1998	Yes	8260B, 624, CLP, 524.2
GC	Hewlett-Packard S/N 3126A36935	5890 II	1998	1998		
Autosampler	EST Archon S/N 12206	5100A	1998	1998		
Concentrator	OI S/N I418460464	4560	1998	1998		

Table 21-1. Example: Laboratory Instrumentation List

Instrument Type	Manufacturer	Model	Purchase Date	Install Date	Autosampler	Method Performed
VOAMS9	Hewlett-Packard S/N 3118A03332	5971	1998	1998	Yes	8260B, 624, CLP, 524.2
GC	Hewlett-Packard S/N 3203A40292	5890 II	1998	1998		
Autosampler	EST Archon S/N 12207	5100A	1998	1998		
Concentrator	OI S/N C302089	4560	1998	1998		
VOAMS10	Hewlett-Packard S/N 3307A00392	5972	1997 (Whippany acquisition)	July /2000 (In Edison)	Yes	8260, 624, CLP, 524.2
GC	Hewlett-Packard S/N 2728414257	5890	Unknown	1997 (In Whippany)		
Autosampler	Teledyne Tekmar S/N 94312017	Aquatek 70	Mar06	May 2008		
Concentrator	Tekmar S/N 94087010	3000	1997			
VOAMS11	Agilent S/N US30965664	5973N	Jun03	Jul03	Yes	8260B, 624, CLP, 524.2
GC	Agilent S/N CN10324011	6890N	Jun03	Jul03		
Autosampler	EST Archon S/N 13970	5100A	Jun03	Jul03		
Concentrator	EST S/N 279061703	Encon	Jun03	Jul03		

Table 21-1. Example: Laboratory Instrumentation List

Instrument Type	Manufacturer	Model	Purchase Date	Install Date	Autosampler	Method Performed
VOAMS12	Agilent S/N US43110519	5973inert	Oct04	Nov04	Yes	8260, 624, CLP, 524.2
GC	Agilent S/N CN10439051	6890N	Oct04	Jun05		
Autosampler	EST S/N 14448	Archon 5100A	May05	Jun05		
Concentrator	EST S/N 430051605	Encon	May05	Jun05		
Turbo Pump Upgrade	Agilent S/N 56115832	Performance	Jun05	Jun05		
VOAMS13	Agilent S/N US43110517	5973inert	Oct04	Nov04	Yes	8260, 624, CLP, 524.2
GC	Agilent S/N CN10439052	6890N	Oct04	Jun05		
Autosampler	EST S/N 14449	Archon 5100A	May05	Jun05		
Concentrator	EST S/N 431051605	Encon	May05	Jun05		
Turbo Pump Upgrade	Agilent S/N 56069171	Performance	Jun05	Jun05		
Balance #22	Mettler 2115517886	PB1501	1997	1997	No	8260, 8015 GRO
Balance #50	Ohaus 1125573353	Explorer Pro	2006	2006	No	8260, 8015 GRO
Balance # 103	Denver Instruments 126008		2009	2009	No	8260
Oven Drying	Fisher Isotemp Oven 502N0045	13-246-516G	2/15/2005	3/3/2005	N0	
Oven Drying	Baxter 199012	DX-1	2000	2000	No	

Table 21-1. Example: Laboratory Instrumentation List

Instrument Type	Manufacturer	Model	Purchase Date	Install Date	Autosampler	Method Performed
GC Volatiles					Yes	8015B (GRO)
GC1	Agilent S/N US10610006	6890N	Mar06	May06		
Autosampler	OI S/N 14608	4552	Feb06	May06		
Concentrator	OI S/N D607466340	4660	Feb06	May06		
Autosampler	OI S/N D60745B342	4551A	Feb06	May06		
Concentrator	OI S/N D607466341	4660	Feb06	May06		
Spiker	OI S/N E610475713	SAM	Feb06	May06		
GC2	Hewlett-Packard S/N 2921A23492	5890II	1993	1993	Yes	Screening/3810
Autosampler 1	Tekmar S/N US04156005	7050	Jun04	Jul04		
Headspace 1	Tekmar S/N US04156003	7000	Jun04	Jul04		
Autosampler 2	Tekmar S/N US04148014	7050	Jun04	Jul04		
Headspace 2	Tekmar S/N US04163001	7000	Jun04	Jul04		
GC3	Hewlett-Packard S/N 3310A49242	5890II	1996	1996	Yes	8015B (GRO)
PID	OI S/N 91-I107	4430	1996	1996		
Autosampler	Dynatech Archon S/N 11780-795	5100	1996	1996		
Concnetrator	OI S/N J437460274	4560	1996	1996		
SCREEN1/2 GC	Hewlett-Packard S/N 2950A29246	5890 II	1989	1989	Yes	Screening
Autosampler 1	Tekmar S/N 91025014	7050	1989	1989		
Headspace 1	Tekmar S/N 91163066	7000	1989	1989		
Autosampler 2	Tekmar S/N 91168012	7050	1989	1989		
Headspace 2	Tekmar S/N 90255003	7000	1989	1989		

Table 21-1. Example: Laboratory Instrumentation List

Instrument Type	Manufacturer	Model	Purchase Date	Install Date	Autosampler	Method Performed
SCREEN3/4 GC	Hewlett-Packard S/N 2908A21857	5890	1998	1998	Yes	Screening/3810
Autosampler 1	Tekmar S/N 91346013	7050	1998	1998		
Headspace 1	Tekmar S/N 91339015	7000	1998	1998		
Autosampler 2	Tekmar S/N 90256011	7050	1998	1998		
Headspace 2	Tekmar S/N 91025010	7000	1998	1998		
H-Nu PID	H-nu Systems S/N 801023	PI101	1989	1989	No	Headspace Screening
Hood Ductless Fume	Air Science P41007	PurAir15	Oct04	Nov04	No	
GC Semivolatiles BNAGC1 GC Network Injector Module Tray	Agilent Technologies S/N US10248079 S/N CN24428026 S/N CN24322270	6890N G2613A G2614A	2003	2005	Yes	NJDEP-OQA-QAM-025
BNAGC3 GC Network Tower Tray	Hewlett Packard S/N 2643A12162 S/N C11144007157KG S/N C11154003268KG	5890 II	1987	1987	Yes	GC Fingerprints
BNAGC4 GC Network Injector Module 1 Injector Module 2 Tray	Agilent Technologies S/N US10610005 S/N CN43820808 S/N CN43820804 S/N CN43830663	6890N G2913A G2914A G2614A	Feb06	Apr06	Yes	8015B DRO/Fingerprints QAM-025
BNAGC5 GC Tower Tray Controller	Hewlett-Packard S/N 2728A14513 S/N 2704A0854 S/N 2920A10887 S/N 01866	5890 7673	1997	1997	Yes	8015B Alcohols
BNAGC6 GC Tower 1 Tower 2 Tray Controller	Hewlett-Packard S/N 3203A40054 S/N 3120A28315 S/N 3202A27987 S/N 3228A29094 S/N 3138A27180	5890 II 7673	1997	1997	Yes	8015B Amines

Table 21-1. Example: Laboratory Instrumentation List

Instrument Type	Manufacturer	Model	Purchase Date	Install Date	Autosampler	Method Performed
BNAGC7	Hewlett-Packard		1999	1999	Yes	8015B Glycols
GC	S/N 2443A03923	5890				
Tower 1	S/N 2546A02013	7673A				
Tray	S/N 2718A05293					
Controller	S/N 2929A15891					

Table 21-1. Example: Laboratory Instrumentation List

Instrument Type	Manufacturer	Model	Purchase Date	Install Date	Autosampler	Method Performed
Pest/PCB						
	Hewlett-Packard		1992	1992	Yes	8081, CLP
GC1	S/N 2612A07669	5890A				
GC Mainframe	S/N CN22321930	G1513A				
Injector Module	S/N CN00005085	G1512A				
Controller	S/N US72101578	18596C				
Tray						
GC2	Hewlett-Packard		1992	1992	Yes	OUT OF SERVICE
GC Mainframe	S/N 2750A15933	5890A				
Injector Module 1	S/N 2932A14269	18593A				
Injector Module 2	S/N 2704A8875	18593A				
Controller	S/N 2749A09358	18594A				
Tray	S/N 2718A08934	18596A				
GC3	Hewlett-Packard		1992	1992	Yes	Herbicides
Series II GC	S/N 3223A42873	5890A				
Injector Module	S/N 3228A31372	18593B				
Controller	S/N 3049A23890	18594B				
Tray	S/N 3202A27453	18596B				
GC4	Hewlett-Packard		1997	1997	Yes	8081
Series II Plus GC	S/N 336A54563	5890A				
Injector Module	S/N 3013A22344	18593B				
Controller	S/N 3227A29129	18594B				
Tray	S/N 3624A42191	18596B				
GC5	Agilent Technologies		2002	2002	Yes	8081
GC Network	S/N US10226033	6890N				
Injector Module	S/N CN22025340	G2613A				
Tray	S/N CN21420543	G2614A				
GC6	Hewlett-Packard		1998	1998	Yes	608
GC Mainframe	S/N 2950A26642	5890A				
Injector Module	S/N CN13420438	G1513A				
Controller	S/N CN00004777	G1512A				
Tray	S/N US20407961	18596C				
GC7	Hewlett-Packard		1998	1998	Yes	8082
GC Mainframe	S/N 3029A29927	5890A				
Injector Module	S/N C11144007141	18593A				
Controller	S/N 626059	18594A				
Tray	S/N C11154103504	18596A				
GC8	Agilent Technologies		2000	2000	Yes	8082
GC Plus	S/N US00004463	6890				
Injector Module	S/N CN15221154	G1513A				
Controller	S/N 3631A05939	G1512A				
Tray	S/N 3050A23572	18596C				

Table 21-1. Example: Laboratory Instrumentation List

Instrument Type	Manufacturer	Model	Purchase Date	Install Date	Autosampler	Method Performed
GC9	Agilent Technologies		2001	2001	Yes	8082
GC Plus	S/N US00043694	6890				
Injector Module	S/N CN13420437	G1513A				
Controller	S/N CN00004150	G1512A				
Tray	S/N US13807350	18596C				
GC11	Agilent Technologies		2003	2003	Yes	CLP
GC Plus	S/N US00008746	6890				
Injector Module	S/N US64600228	G2513A				
Controller	S/N US72202100	G2512A				
Tray	S/N US22408138	18596C				
WET CHEMISTRY						
Spectrophotometer	HACH S/N 1205122	DR2800	2007	2007	No	365.2, 7196A, 353.2, 410.4
Spectrophotometer	HACH S/N 1204684	DR2800	2007	2007	No	365.2, 7196A, 353.2, 410.4
Spectrophotometer	HACH S/N 11204422	DR2800	2007	2007	No	7196A, USGS
Turbidimeter	HF Scientific S/N 200604033	Micro 100	2006	2006	No	180.1, SM 2130B
Ion Selective Meter	Orion S/N 006825	720A	1994	1994	No	350.1+ .2, 340.2, 150.1
Ion Selective Meter	Orion S/N 092904	720A+	2007	2007	No	350.1+ .2, 340.2, 150.1
pH Meter	Orion S/N 010005	320	2002	2002	No	Cr6+
pH Meter	Orion S/N 009986	320	2002	2002	No	350.1/4500 NH3 H
pH Meter	Orion 320 S/N 016995	320	2002	2002	No	TCLP (1311)
pH meter	Orion 320 S/N 017414	320		2009	No	4500-H B
Oven	VWR S/N 0402001	1320	2001	2001	No	2540C
Oven	VWR	1300U	2001	2001	No	2540C
Oven	VWR	1305U	2001	2001	No	2540B
Oven	Fisher	230G	1997	1997	No	2540B, 2540D
Oven (Muffle Furnace)	Fisher S/N 901N002	550-14	2002	2002	No	160.4
Oven drying	VWR	1320	2001	2001	No	
Balance #27	A&D 12315883	HR-200	2005	2005	No	Gen. chem.
Balance #29	A&D 12315872	HR-200	2005	2005	No	160.1, 160.2
Balance #26	Sartorius 3503054	1712MP8	2003	2003	No	Gen. chem.
Balance #51	Ohaus 7125010794	Scout Pro	2006	2006	No	1311 (TCLP), 3060A
Balance #100	Mettler 122423439		2006	2006	No	Lloyd Kahn (TOC)
Balance # 101	Denver Instrument 126009		2009	2009	No	Gen. chem.

Table 21-1. Example: Laboratory Instrumentation List

Instrument Type	Manufacturer	Model	Purchase Date	Install Date	Autosampler	Method Performed
Water Bath	Precision S/N 9302-112	50	1995	1995	No	7196A
Water Bath	Precision S/N 9305-024	50	1995	1995	No	7196A
Water System (Log-in)	Millipore S/N 07348-C		1990	1990	No	
Water System (Extr. room)	Barnstead S/N 1191020210415	D11911	1995	1995	No	
FTIR	Perkin Elmer S/N 139038	1600	1991	1991	No	418.1
Printer	Epson S/N 61P107612	FX-870	2003	2003	No	418.1
Fixed IR	Buck Scientific S/N 1026	404	2004	2004	No	418.1
COD reactor	HACH S/N 980300017418	45600	2007	2007	No	410.4, 5220D
COD reactor	HACH S/N 900402268	45600	2007	2007	No	410.4, 5220D
COD reactor	HACH S/N 1202323	DRB 200	2007	2007	No	410.4, 5220D
COD reactor	HACH S/N 1209887	DRB 200	2007	2007	No	410.4, 5220D
Auto-analyzer	Lachat S/N A83000	QUICKEM 8000	1997	1997	Yes	335.3, 420.2, 353.2, 351.2, 350.1+ .2
Auto-analyzer	Lachat S/N 8300-1658	8000 Series	2000	2000	Yes	335.3, 350.1+ .2
TOC Analyzer	Shimadzu S/N 31242909	TOC 5000	1997	1997	Yes	Lloyd Kahn's method, 415.1, 9060, 5310B
Autosampler	Shimadzu S/N 31816800	ASI-5000	1997	1997	Yes	415.1, 5310B, 9060
Solid Sample Module (1)	Shimadzu S/N 31303115	SSM-5000A	1997	1997	No	Lloyd Kahn's method
TOC Soil Analyzer (2)	Thermo Electron Corp. S/N 20034945	Flash EA 1112 Series	2004	2004	Yes	Lloyd Kahn's method
Printer	Epson S/N 41NE28676	LQ570	1997	1997	No	415.1
TOC Analyzer	Shimadzu S/N H51104335164	TOC-VCSH	2006	2006	Yes	Lloyd Kahn's method, 415.1, 9060, 5310B
Autosampler	Shimadzu S/N H52104301656SA	ASI-V	2006	2006	Yes	415.1, 5310B, 9060
Solid Sample Module	Shimadzu S/N H52504300040NK	SSM-500A	2006	2006	Yes	Lloyd Kahn's method
BOD Meter	YSI S/N 97S0534AE	5000	1998	1998	No	405.1
Incubator	GCA Precision Scientific		1998	1998	No	405.1
Hot Plate	Fischer Scientific S/N 103N0071		2001	2001	No	365.2
Hot Plate	Corning S/N 370301092774	PC-400	2007	2007	No	1311
Hot Plate	Fischer Scientific S/N 390502148495	PC-420	2007	2007	No	Lloyd Khan Method
Hot Plate	Fischer Scientific S/N 220897070707	PC-620	2007	2007	No	351.2
Conductivity Meter	Fischer Scientific S/N AB 81209007	Accumetab30	2002	2002	No	120.1, 9050A

Table 21-1. Example: Laboratory Instrumentation List

Instrument Type	Manufacturer	Model	Purchase Date	Install Date	Autosampler	Method Performed
Vortex mixer	Thermolyne S/N 632000855604	M63215	2002	2002	No	351.2
Dishwasher	Miele Professional S/N 208479	G7783CD	2003	2003	No	Glassware
Easy-Dist Distillation	Westco S/N 1095		2003	2003	No	350.1+ .2, 420.2, 9066
Easy-Dist Distillation	Westco S/N J097		2003	2003	No	335.3, 9012A & B
Easy-Dist Distillation	Westco S/N 1063		2007	2007	No	350.1+.2, 420.2, 353.3, 9012A&B
Easy-Dist Distillation	Westco S/N 1110		2007	2007	No	353.3, 420.2, 9066
Discreet Analyzer (1)	Konelab S/N S2019177	20	2003	2003	Yes	Automated Wet Chem
Discreet Analyzer (2)	Konelab S/N 2519236	20	2003	2003	Yes	Automated Wet Chem
Dell Computer	Dell S/N 246175		2003	2003	No	Automated Wet Chem (Konelab)
BOD Aerator	Thomas Scientific S/N 1187	DOA-P104d-AA	1998	1998	No	405.1
BOD Plus Assay Liquid Handler DO meter YSI 52	Mantech Assoc., Inc. S/N 27OC3XB215 S/N O3C0812 AM	 221 & 222 52CE	2003	2003	Yes	405.1
PC-Titration Plus Autotitrator Interface Titra-Rinse 1 Titra-Rinse 2 Buret Module 1 Buret Module 2 Titration Module	Mantech Assoc., Inc S/N MS-0H4-373 S/N MS-0G4-198 S/N MS-0G4-200 S/N MS-0H4-627 S/N MS-0H4-625 S/N MS-0B5-657	 PC-1000-102/4 PC-1000-408 PC-1000-408 PC-1104-00 PC-1104-00 PC-1300-475	2004	2004	Yes	310.1, 2320B – Alkalinity 2320B – Carbonate, Bicarbonate 4500 CO2D – Carbon Dioxide 130.2, 2340C – Hardness
Ion Chromatograph Pump #1 Pump #2 Conduct. Detector Injector & Oven 2-Ch Interface Liq. Handling #1 Liq. Handling #2 Dil. Autosampler	Metrohm Peak, Inc. S/N 04187 S/N 04197 S/N 03181 S/N 04147 S/N 04184 S/N 04154 S/N 04118 S/N 03198	 818 818 819 820 830 833 833 838	May05	May05	Yes	7199
Filter pump	Emerson S/N SA55-NXGTB 4142		1997		No	Sample Filtering
Filter pump	Emerson S/N G8ECX	SA55JXgtd-4144	2002	2002	No	Sample Filtering
Redox meter	VWR S/N 001149	8005	1997	1997	No	SM2580
Rotator 1	AP & R Machine & Tool S/N 222307		2003	2003	No	600/8000/CLP
Rotator 2	AP & R Machine & Tool S/N 222306		2003	2003	No	600/8000/CLP
Rotator 3	AP & R Machine & Tool S/N 222305		2003	2003	No	600/8000/CLP

Table 21-1. Example: Laboratory Instrumentation List

Instrument Type	Manufacturer	Model	Purchase Date	Install Date	Autosampler	Method Performed
Rotator 4	AP & R Machine & Tool S/N 222304		2003	2003	No	600/8000/CLP
Rotator 5	AP & R Machine & Tool S/N 222303		2003	2003	No	600/8000/CLP
Rotator 6	AP & R Machine & Tool S/N 222302		2003	2003	No	600/8000/CLP
TCLP Extraction1 Apparatus/Timer included	Assoc. Design and Mfg. Co. S/N 1352	3740-12 BRE	1997	1997	No	1311 TCLP, ZHE
TCLP Extraction2 Apparatus/Timer included	Assoc. Design and Mfg. Co. S/N 1053	3740-12 BRE	1997	1997	No	1311 TCLP, ZHE
TCLP Extraction3 Apparatus/Timer included	Assoc. Design and Mfg. Co. S/N 1249	3740-12 BRE	1997	1997	No	1311 TCLP, ZHE
TCLP Extraction4 Apparatus/Timer included	Environmental Express Limited S/N 3384-12-473	LE 1002	May05	May05	No	1311 TCLP, ZHE
TCLP Extraction5 Apparatus/Timer included	Environmental Express Limited S/N 3384-12-472	LE 1002	May05	May05	No	1311 TCLP, ZHE
TCLP Extraction6 Apparatus/Timer included	Assoc. Design and Mfg. Co. S/N 2125	3740-12 BREII	Jul06	Sep06	No	1311 TCLP, ZHE
TCLP Extraction7 Apparatus/Timer included	Assoc. Design and Mfg. Co. S/N 2126	3740-12 BREII	Jul06	Sep06	No	1311 TCLP, ZHE
SAMPLE LOGIN						
Balance #13	Satorius S/N 50709085	LC421	1995	1995	No	%Solids
Balance #104	Denver Instruments S/N 126006		2009		No	
Isotemp Oven 1	Fisher S/N 410B01117	637G	Mar05	Mar05	No	%Solids
Isotemp Oven 2	Fisher S/N 505N0063	637G	Jun05	Jun05	No	%Solids
ORGANIC EXTRACTIONS						
N-EVAP #1	Organomation S/N 51004	8125	2004	2004	No	600/8000/CLP
N-EVAP #2	Organomation S/N 10253	N-EVAP 112	1990	1990	No	600/8000/CLP
Water Bath #1	Fisher Scientific S/N 605021280	15-491	2005	2005	No	600/8000/CLP
Water Bath #2	Fisher Scientific S/N (204272)	15-491	2007	2007	No	600/8000/CLP
Sonicator #1	Sonic & Material, Inc. S/N 3353027	VCX 500	2006	2006	No	8000/CLP

Table 21-1. Example: Laboratory Instrumentation List

Instrument Type	Manufacturer	Model	Purchase Date	Install Date	Autosampler	Method Performed
Sonicator #2	Sonic & Material, Inc. S/N 3353028	VCX 500	2006	2006	No	8000/CLP
Sonicator #3	Tekmar S/N 7918	TM500	1990	1990	No	8000/CLP
Sonicator #4 (share controller with son #3)	Tekmar S/N 7918	TM500	1990	1990	No	8000/CLP
Sonicator #5	Sonic & Material, Inc. S/N 41748	VCX 500	2004	2004	No	8000/CLP
Sonicator #6	Sonic & Material, Inc. S/N 41755	VCX 500	2004	2004	No	8000/CLP
Muffle Furnace #1	Thermolyne S/N 40800875	F6010	1990	1990	No	600/8000/CLP
Muffle Furnace #2	Thermolyne S/N (warn out)	F6028C	1990	1990	No	600/8000/CLP
Large Muffle Furnace	Wilt Industries S/N 041213	210	2001	2001	No	600/8000/CLP
Dishwasher #1	Miele Professional S/N 53075564	G7783CD	2003	2003	No	608/8000/CLP
Dishwasher #2	Miele Professional S/N 53075571	G7783CD	2003	2003	No	608/8000/CLP
Vacuum Pump #1	Emerson electric MLD S/N UNL231171	5KH36KN90HX	1990	1990	No	600/8000/CLP
Vortex	Scientific Industries S/N 2-318564	6560	1995	1995	No	600/8000/CLP
Electric Mixer	Barnstead/Thermolyne S/N 125404091646		1995	1995	No	600/8000/CLP
Mini Hotplate/Stir	VWR Scientific S/N 33918-604	220	1995	1995	No	600/8000/CLP
Centrifuge #1	Sigma S/N 78646	2-5	2001	2001	No	600/8000/CLP
Centrifuge #2	Sigma S/N 78647	2-5	2001	2001	No	600/8000/CLP
Centrifuge #3 (Out of Service)	Sigma S/N 80226	2-5	2001	2001	No	600/8000/CLP
Balance # 60	Ohaus S/N 7125471186	Scout Pro	2007	2007	No	600/8000/CLP
Balance #28	A&D S/N 12315879	HR-200	2005	2005	No	600/8000/CLP
Balance #30	A&D S/N 12315880	HR-200	2005	2005	No	600/8000/CLP
Soxtherm 1 Controller Chiller	OI Analytical S/N 4012358 S/N 4012351 S/N 10200022	Type 07-5101	2002	2002	No	8000

Table 21-1. Example: Laboratory Instrumentation List

Instrument Type	Manufacturer	Model	Purchase Date	Install Date	Autosampler	Method Performed
Soxtherm 2 Controller Chiller	OI Analytical S/N 4010018 S/N 4010088 S/N 10200022	Type 07-5101	2002	2002	No	8000
Soxtherm 3 Controller Chiller	OI Analytical S/N 4012359 S/N 4002805 S/N 10365037	Type 07-5101	2002	2002	No	8000
Soxtherm 4 Controller Chiller	OI Analytical S/N 429023 S/N 4022012 S/N 101365037	Type 07-5101	2002	2002	No	8000
Soxtherm 5 Controller Chiller	Gerhardt S/N 4073032 S/N 4051753 S/N 107344070 (Thermo)	SOX 416	2007	2007	No	8000
Soxtherm 6 Controller Chiller	Gerhardt S/N 4073033 S/N 4051753 S/N 107344070 (Thermo)	SOX 416	2007	2007	No	8000
Soxtherm 7 Controller Chiller	Gerhardt S/N 4073030 S/N 4051753 S/N 107344069 (Thermo)	SOX 416	2007	2007	No	8000
Soxtherm 8 Controller Chiller	Gerhardt S/N 4073031 S/N 4051753 S/N 107344069 (Thermo)	SOX 416	2007	2007	No	8000
Soxtherm 9 Controller Chiller	OI Analytical S/N 4012357 S/N 4012354 S/N 101361126	Type 07-5101	2003	2003	No	8000
Soxtherm10 Controller Chiller	OI Analytical S/N 4010016 S/N 4012353 S/N 101361126	Type 07-5101	2003	2003	No	8000

Table 21-1. Example: Laboratory Instrumentation List

Instrument Type	Manufacturer	Model	Purchase Date	Install Date	Autosampler	Method Performed
Soxtherm11 Controller Chiller	OI Analytical S/N 4012356 S/N 480017 S/N 102002024	Type 07-5101	2005	2005	No	8000
Soxtherm12 Controller Chiller	OI Analytical S/N 4033530 S/N 401812 S/N 102002024	Type 07-5101	2005	2005	No	8000
Soxtherm13 Controller Chiller	Gerhardt S/N 4031667 S/N 4051747 S/N 101361121	SOX416 1177PD	2006	2006	No	8000
Soxtherm 14	Gerhardt S/N 4031666 S/N 4051747 S/N 101361121	SOX416	2006	2006	No	8000
Soxtherm 15	Gerhardt S/N 4051583 S/N 4051747 S/N 10650017 (VWR)	SOX416	2006	2006	No	8000
Soxtherm 16	Gerhardt S/N 4051582 S/N 4051747 S/N 10650017 (VWR)	SOX416	2006	2006	No	8000
Wrist Action Shaker 1	Burrell S/N	75	2003	2003	No	8151
Wrist Action Shaker 2	Labline S/N 12910443	3589	2003	2003	No	8151
FIELD SERVICES pH/Temp meter	Thermo Orion 15035	250A+	2000	2000	No	pH, Temperature
Conductivity meter	HACH 21000005660	Sension 5	2002	2002	No	Conductivity
DO meter	HACH 0200001321	Sension 6	2002	2002	No	Dissolved Oxygen
DO meter	HACH 001200002352	Sension 6	2000	2000	No	Dissolved Oxygen
Turbidity meter	La Motte 0119-0997	2020	1998	1998	No	Turbidity
Turbidity meter	La Motte 3897-5102	2020	2002	2002	No	Turbidity
Turbidity meter	LaMotte 3649-3802	2020	2002	2002	No	Turbidity
pH/ORP meter	Cole Parmer 643409	05669-20			No	pH, Oxidation reduction
pH/ORP meter	HACH 31100003358	Sension 1	2005	2005	No	pH, Oxidation reduction

Table 21-1. Example: Laboratory Instrumentation List

Instrument Type	Manufacturer	Model	Purchase Date	Install Date	Autosampler	Method Performed
Cond./Salinity/ TDS meter	HACH 30500006215	Sension 5			No	Conductivity, Salinity, TDS
pH/ ORP meter	HACH 050400020239	Sension 1	2005	2005	No	pH, Oxidation reduction
pH/ ORP meter	HACH 050400022762	Sension 1	2005	2005	No	pH, Oxidation reduction
Cond./Salinity/ TDS meter	HACH 050300013668	Sension 5	2005	2005	No	Conductivity, Salinity, TDS
Cond./Salinity/ TDS meter	YSI 93L12159	33			No	Conductivity, Salinity, TDS
Turbidity meter	LaMotte ME 10036	2020e	2005	2005	No	Turbidity
Turbidity meter	LaMotte ME 10117	2020e	2005	2005	No	Turbidity
Cond./Salinity/ TDS meter	HACH 050506C50148	Sension 5	2005	2005	No	Conductivity, Salinity, TDS
DO meter	HACH 050500C60212	Sension 6	2005	2005	No	Dissolved oxygen
DO meter	HACH 050500C60066	Sension 6	2005	2005	No	Dissolved oxygen
pH/ ORP meter	HACH 050600C10445	Sension 1	2005	2005	No	pH, Oxidation reduction
pH/ ORP meter	HACH 4030004162	Sension 1	2005	2005	No	pH, Oxidation reduction
DO meter	Hach 040800001267		2006	2006	No	Dissolved Oxygen
Conductivity meter	Hach 050100002708		2006	2006	No	Conductivity
DO meter	Hach 040700001191		2006	2006	No	Dissolved Oxygen
pH/ mV meter	Hach 040200003831		2006	2006	No	pH, mV
Conductivity meter	Hach 050100002707		2006	2006	No	Conductivity
DO meter	Hach 030500007618		2006	2006	No	Dissolved Oxygen
pH/ mV	Hach 041200004666		2006	2006	No	pH, mV
Turbidity meter	LaMotte 4969-1604		2006	2006	No	Turbidity
Turbidity meter	LaMotte 4943-1604		2006	2006	No	Turbidity
Turbidity meter	LaMotte 1909-2900		2006	2006	No	Turbidity
pH/mV meter	Hach 041200002902		2006	2006	No	pH, mV
pH/mV meter E-019	Hach 41200002933	Sension 1	2006	2006	No	pH, mV
Conductivity meter E-027	Hach 050500C50193	Sension 5	2006	2006	No	Conductivity
pH meter E-028	Hach 040800010007	Sension 1	2006	2006	No	pH meter
pH/mV meter M-039	Hach 0804C410063	Sension 1				pH/ORP
pH/mV meter M-034	Hach 06070C710134	Sension 1	Oct06	Oct06	No	pH/ORP
Conductivity meter M-028	Hach 050500C50288	Sension 5	Aug05	Aug05	No	Conductivity

Table 21-1. Example: Laboratory Instrumentation List

Instrument Type	Manufacturer	Model	Purchase Date	Install Date	Autosampler	Method Performed
DO meter M-032	Hach 05070C360249	Sension 6	Nov06	Nov06	No	DO
pH/mV meter M-036	Hach 07080C710259	Sension 1	Oct07	Oct07	No	pH/ORP
pH/mV meter M-030	Hach 050600C10468	Sension 1	Aug05	Aug05	No	pH/ORP
pH/mV meter M-037	Hach 08020c110145	Sension 1	Mar08	Mar08	No	pH/ORP
DO meter E-030	Hach 07120C260018	Sension 6	2008	2008	No	DO
pH E-031	Thermo Orion 018168	Model 230			No	pH
pH/ORP E-029	Hach 07070C610178	Sension1	2008	2008	No	pH/ORP
DO E-032	YSI 01F0708AA	55/25 FT			No	DO
pH E-033	Thermo Orion 017788	Model 230A			No	pH
pH E-034	Thermo Orion 017630	Model 230A			No	pH
Chlorine meter CL-007	Hach 040200011290	Pocket Colorimeter II	2006	2006	No	330.5, SM 18th 4500 Cl G
Chlorine meter CL-002	Hach 020100174404	Pocket Colorimeter	2006	2006	No	330.5, SM 18th 4500 Cl G
Chlorine meter CL-003	Hach 040200011345	Pocket Colorimeter II	2006	2006	No	330.5, SM 18th 4500 Cl G
Chlorine meter CL-004	Hach 961200102549	Pocket Colorimeter	2006	2006	No	330.5, SM 18th 4500 Cl G
Chlorine meter CL-006	Hach 030400034505	Pocket Colorimeter	2005			
Chlorine meter CL-005	Hach 020100174252	Pocket Colorimeter	2006			
Chlorine meter CL-008	Hach 4796-4900	Colorimeter 1200				
Colorimeter M-040	Hach 041050031426	48450-60 DR/850			No	
Water level meter	Solonist S/N 37993		Jan05	Feb05	No	
Water level meter	Solonist S/N 37995		Jan05	Feb05	No	
Water level meter	Solonist S/N 42807		Jan06	Jan06	No	
Water level meter	Fisher				No	
PID meter	RAE Systems S/N 110-010953	PGM-7600	May05	May05	No	
PID meter	RAE Systems S/N 110-010984	Mini RAE 2000	May05	May05	No	
PID meter	RAE Systems S/N 110-01094	Mini Rae 2000	May05	May05	No	
PID meter	RAE Systems S/N 103958	Plus Classic	Jan05	Jan05	No	
PID meter	PE Photovac S/N DQGD302	2020			No	
Comp sampler	ISCO S/N 205C01376	603704001-3700	May05	May05	Yes	
Comp sampler	ISCO S/N 205C01380	603704001-3700	May05	May05	Yes	

Table 21-1. Example: Laboratory Instrumentation List

Instrument Type	Manufacturer	Model	Purchase Date	Install Date	Autosampler	Method Performed
Comp sampler	ISCO S/N 204G00984	3700			Yes	
Comp sampler	ISCO S/N 05248-001	2700			Yes	
Comp sampler	ISCO	2700			Yes	
Comp sampler	ISCO	2700			Yes	
Comp sampler	ISCO	2700			Yes	
Submersible pump	Grundfos S/N 05141-8349	MP1 / 1A106003	May05	May05	No	
Submersible pump	Grundfos S/N 05141-8361	MP1 / 1A106003	May05	May05	No	
Submersible pump	Grundfos S/N 0621-0014	A1A106003P1	Jul06	Jul06	No	
Submersible pump	Grundfos S/N 06029591				No	
Submersible pump	Grundfos S/N 98490294				No	
Submersible pump	Grundfos				No	
Submersible pump	Grundfos				No	
Submersible pump	Grundfos				No	
Submersible pump	Proactive S/N 1371	SS Monsoon	July06	Jul06	No	
Pump control box	Grundfos S/N H0412210120	91126028	May05	May05	No	
Pump control box	Grundfos S/N H0412210120	91126028	May05	May05	No	
Pump control box	Grundfos S/N P1940304254		May05	May05	No	
Pump control box	Grundfos S/N 203831		May05	May05	No	
Pump control box	Grundfos S/N H0303130012		May05	May05	No	
Pump control box	Grundfos S/N 9517		May05	May05	No	
Pump control box	Grundfos		May05	May05	No	
Pump control box	ProActive	Low-flow with power booster	Jul06	Jul06	No	
Trash pump	North Star S/N E06	10633	2007	2007	No	
Generator	Honda S/N EB-3000C	EZGP-1145763	May05	May05	No	
Generator	Honda S/N EB-3000C	EZGP-1151238	Jun05	Jun05	No	
Generator	Honda S/N EZGL1002930	EB-3000C	2005	2005	No	
Generator	Honda				No	
Generator	Honda				No	
Control Pack	QED S/N MP15-1300	MP-15	May05	May05	No	
Control Pack	QED S/N MP15-1297	MP-15	May05	May05	No	

Table 21-1. Example: Laboratory Instrumentation List

Instrument Type	Manufacturer	Model	Purchase Date	Install Date	Autosampler	Method Performed
Control Pack	QED S/N MP15-1298	MP-15	May05	May05	No	
Control Pack	QED S/N MP15-1299	MP-15	May05	May05	No	
Control Pack	QED	MP-15	May05	May05	No	
Control Pack	QED	MP-15	May05	May05	No	
Control Pack	QED	MP-15	May05	May05	No	
Control Pack	QED	MP-15	May05	May05	No	
Control Pack	QED	MP-15	May05	May05	No	
Bladder Pump	QED S/N 10993	MP-SPK-4P	May05	May05	No	
Bladder Pump	QED S/N 10997	MP-SPK-4P	May05	May05	No	
Bladder Pump	QED S/N 10995	MP-SPK-4P	May05	May05	No	
Bladder Pump	QED S/N 10996	MP-SPK-4P	May05	May05	No	
Bladder Pump	QED S/N 11191	MP-SPK-4P	May05	May05	No	
Bladder Pump	QED S/N 11192	MP-SPK-4P	May05	May05	No	
Bladder Pump	QED 11512	MP-SPK-4P	May05	May05	No	
Bladder Pump	QED 10948	MP-SPK-4P	May05	May05	No	
Bladder Pump	QED 10949	MP-SPK-4P	May05	May05	No	
Bladder Pump	QED	MP-SPK-4P	May05	May05	No	
Bladder Pump	QED	MP-SPK-4P			No	
Bladder Pump	QED	MP-SPK-4P			No	
Peristaltic Pump	Solonist S/N 002562	410			No	
Peristaltic Pump	Solonist S/N 002071	410			No	
Peristaltic Pump	Solonist S/N 001979	410			No	
Peristaltic Pump	Solonist S/N 002642	410			No	
Peristaltic Pump	ISCO	Accuwell 150 portable pump			No	
Peristaltic Pump	ISCO	Accuwell 150 portable pump			No	
Peristaltic Pump	ISCO	Accuwell 150 portable pump			No	
Peristaltic Pump	ISCO	Accuwell 150 portable pump			No	
Peristaltic Pump	ISCO	Accuwell 150 portable pump			No	
Peristaltic Pump	ISCO	Accuwell 150 portable pump			No	
Centrifugal Pump	Teel S/N 3021	2P110B			No	

Table 21-1. Example: Laboratory Instrumentation List

Instrument Type	Manufacturer	Model	Purchase Date	Install Date	Autosampler	Method Performed
Centrifugal Pump	Teel S/N 0036	2P110B			No	
Centrifugal Pump	Teel S/N 0034	2P110B			No	
Centrifugal Pump	Teel S/N 1962	2P110B			No	
Centrifugal Pump	Teel	2P110B			No	
Compressor	Coleman / Honda S/N D02812339	CT5090412	Jun05	Jun05	No	
Compressor	Honda/Campbell Hausfeld S/N VT697203AJ				No	
Multi-probe meter YSI-1	YSI S/N 06F1362AC	556 MPS	Jul06	Jul06	No	
GPS	Ashtech 10564	110454-01			No	
Oil/Water Interface probe	Testwell					
Oil/Water Interface probe	Testwell					
Oil/Water interface Probe	Solonist 122-008699-1	122	Sept07	Sept07	No	
Oil/Water interface probe	Solonist S/N 122 007364-1		Aug06	Aug06	No	

Table 21-2. Example: Schedule of Routine Maintenance

Instrument	Procedure	Frequency
AA (Graphite Furnace)	Clean lens and furnace head	Daily
	Replace windows	As required
	Check or change cuvette	Daily
	Check & drain compressor drain	Daily
	Clean atomizer cell/furnace hood	Daily
	Nebulizer cleaned/dried	Weekly or as required
	Check/change marble stones	Weekly
	Clean filters	Weekly
	Change graphite tube/platform	As required
	Empty waste container	Daily
	Remove carbon tube and check wear	Daily
	Check sample introduction probe	Daily
Leeman Mercury Analyzer	Check tubing for wear	Daily
	Fill rinse tank with 10% HCl	Daily
	Change dryer tube	As needed
	Fill reductant bottle with 10% Stannous Chloride	Daily
ICP	Check pump tubing	Daily
	Check liquid argon supply	Daily
	Check fluid level in waste container	Daily
	Check filters	Weekly
	Clean or replace filters	As required
	Check torch	Daily
	Check sample spray chamber for debris	Monthly
	Clean and align nebulizer	Monthly
	Check entrance slit for debris	Monthly
	Change printer ribbon	As required
	Replace pump tubing	As required
ICP MS	Change pump tubing	Weekly or As required
	Clean torch	Weekly or As required
	Check / clean nebulizer	Weekly or As required
	Clean cones	Weekly or As required
	Check air filters	Weekly or As required
	Check multiplier voltages & do cross calibration	Weekly or As required
	Replace sample uptake tubing	Weekly or As required
	Check rotary pump oil	Weekly or As required
	Check oil mist filters	Monthly
	Check chiller water level	Monthly
UV-Vis Spectrophotometer	Clean ambient flow cell	As required
	Precision check/alignment of flow cell	As required
	Wavelength verification check	Semi-annually
Auto Analyzers	Clean sampler	Daily
	Check all tubing	Daily
	Clean inside of colorimeter	Daily
	Clean pump well and pump rollers	Quarterly
	Clean wash fluid receptacle	Weekly
	Oil rollers/chains/side rails	Weekly
	Clean optics and cells	Quarterly

Table 21-2. Example: Schedule of Routine Maintenance

Instrument	Procedure	Frequency
Hewlett Packard/Agilent GC/MS	Ion gauge tube degassing Pump oil-level check Pump oil changing Analyzer bake-out Analyzer cleaning Resolution adjustment COMPUTER SYSTEM AND PRINTER: Air filter cleaning Change data system air filter Printer head carriage lubrication Paper sprocket cleaning Drive belt lubrication	As required Monthly Annually As required As required As required As required As required As required As required As required
Gas Chromatograph	Compare standard response to previous day or since last initial calibration Check carrier gas flow rate in column Check temp. of detector, inlet, column oven Septum replacement Glass wool replacement Check system for gas leaks with SNOOP Check for loose/frayed wires and insulation Bake injector/column Change/remove sections of guard column Replace connectors/liners Change/replace column(s)	Daily Daily via use of known compound retention Daily As required As required W/cylinder change as required Monthly As Required As Required As Required As Required
Electron Capture Detector (ECD)	Detector wipe test (Ni-63) Detector cleaning	Semi-annually As required
Flame Ionization Detector (FID)	Detector cleaning	As required
Photoionization Detector (PID)	Change O-rings Clean lamp window	As required As required
HPLC	Change guard columns Change lamps Change pump seals Replace tubing Change fuses in power supply Filter all samples Change autosampler rotor/stator	As required As required Semi-annually or as required As required As required Daily As required
Balances	Class "S" traceable weight check Clean pan and check if level Field service	Daily, when used Daily At least Annually
Conductivity Meter	0.01M KCl calibration Conductivity cell cleaning	Daily As required
Turbidimeter	Check light bulb	Daily, when used
Deionized/Distilled Water	Daily conductivity check Check deionizer light Monitor for VOA's System cleaning Replace cartridge & large mixed bed resins	Daily Daily Daily As required As required

Table 21-2. Example: Schedule of Routine Maintenance

Instrument	Procedure	Frequency
Drying Ovens	Temperature monitoring Temperature adjustments	Daily As required
Refrigerators/ Freezers	Temperature monitoring Temperature adjustment Defrosting/cleaning	Daily As required As required
Vacuum Pumps/ Air Compressor	Drained Belts checked Lubricated	Weekly Monthly Semi-annually
pH/Specific Ion Meter	Calibration/check slope Clean electrode	Daily As required
BOD Incubator	Temperature monitoring Coil and incubator cleaning	Daily Monthly
Centrifuge	Check brushes and bearings	Every 6 months or as needed
Water baths	Temperature monitoring Water replaced	Daily Monthly or as needed

SECTION 22

MEASUREMENT TRACEABILITY *(NELAC 5.5.6)*

22.1 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 21.3). With the exception of Class A Glassware (including glass microliter syringes that have a certificate of accuracy), 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 should be routinely inspected for chips, acid etching or deformity. If the Class A glassware is suspect, the accuracy of the glassware will be assessed prior to use.

22.2 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.

22.3 REFERENCE STANDARDS / MATERIALS

Reference standards/materials, where commercially available, are traceable to certified reference materials. Commercially prepared standard materials are purchased from vendors accredited by A2LA or NVLAP ,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.

22.4 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* the applicable analytical departments. 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.

22.4.1 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
- Department
- Preparer's name
- Final volume and number of vials prepared
- Solvent type and lot number
- Preparation Date

- Expiration Date
- Standard source type (stock or daughter)
- Standard type (spike, surrogate, other)
- 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 (either electronically or hard-copy) 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.

22.4.2 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 (Specify from LIMS or logbook)
- Special Health/Safety warnings if applicable

22.4.3 In addition, the following information may be helpful:

- Date of receipt for commercially purchased items or date of preparation for laboratory prepared items
- 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 a preparation date, 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 SOPs.

SECTION 23

SAMPLING *(NELAC 5.5.7)*

23.1 OVERVIEW

The laboratory provides the following sampling and field services. :

- Groundwater Sampling
- Wastewater Sampling
- Potable Sampling
- Waste Sampling
- Soil and Sediment Sampling
- Flow Monitoring
- Field Parameter Analysis
- Cleaning and Decontamination of Field Equipment

23.2 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.

23.2.1 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 Hydroxide – Instra-Analyzed or equivalent
- Sulfuric Acid – Instra-Analyzed or equivalent
- Sodium Thiosulfate – ACS Grade or equivalent

23.3 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.

23.4 SAMPLING CONTAINERS, PRESERVATION REQUIREMENTS, HOLDING TIMES

The preservation and holding time criteria specified in the method SOPs are derived from the source documents for the methods. If method required holding times (as specified in the method SOPs) 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.

23.5 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 SOP No. ED-GEN-007 (Subsampling).

SECTION 24

HANDLING OF SAMPLES *(NELAC 5.5.8)*

Sample management procedures at the laboratory ensure that sample integrity and custody are maintained and documented from sampling/receipt through disposal.

24.1 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 24-1.

24.1.1 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 24-1). This form includes 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.

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. 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. Samples are only considered to be received by lab when personnel at the laboratory 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 the lab job folder.

24.1.2 Legal / Evidentiary Chain-of-Custody

The laboratory may, upon special request, adhere to legal/evidentiary chain of custody requirements. If TestAmerica agrees to such procedures the samples are identified for legal/evidentiary purposes on the COC, login will complete the custody seal (Figure 24-2), retain the shipping record with the COC, and initiate an internal COC (Figure 24-3) for laboratory use by analysts and a sample disposal record (Figure 24-4).

24.2 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.

24.2.1 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 via the Sample Receipt application within TALS (the laboratory LIMS) and brought to the immediate attention of the appropriate Project Manager who will, in turn, contact 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.

24.2.1.1 Sample Acceptance Policy

The laboratory has a written sample acceptance policy (Figure 24-2) that clearly outlines the circumstances under which samples shall be accepted or rejected. These include:

- a COC filled out completely;
- samples must be properly labeled;
- proper sample containers with adequate volume for the analysis and necessary QC;
- samples must be preserved according to the requirements of the requested analytical method;

- sample holding times must be adhered to;
- all samples submitted for water/solid Volatile Organic analyses must have a Trip Blank submitted at the same time;
- 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.

24.2.1.2 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.

24.2.1.3 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 SOP No. ED-SPM-001.

24.3 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 suitable for the sample matrix. Sample containers designated for metals only analysis are stored un-refrigerated. 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 every week.

Analysts and technicians retrieve the sample container allocated to their analysis from the designated refrigerator and place them on carts, analyze the sample, and return the remaining sample or empty container to the refrigerator from which it originally came. All unused portions of samples, including empty sample containers, are returned to the secure sample control area. All samples are kept in the refrigerators for 30 days after delivery of the final report to the client, which meets or exceeds most sample holding times. After 30 days the samples are disposed of or, upon client request moved to an un-refrigerated sample archive area where they are stored for an additional time period agreed upon with the client.

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.

24.4 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.

Procedures for the handling and storage of hazardous samples is addressed in the TestAmerica Corporate Safety Manual (Test Amercia Document No. CW-E-M-001) and in TestAmerica Edison SOP No. ED-SPM-001 (Sample Receipt, Login, Identification, And Storage).

Procedures for the acceptance and handling of USDA regulated domestic and foreign soils are detailed in TestAmerica SOP No. ED-SPM-006 (Procedure for Acceptance and Handling of Regulated Domestic and Foreign Soil).

24.5 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. 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.

24.6 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, TestAmerica Edison SOP No. ED-SPM-007 (Disposal of Samples and Associated Laboratory Waste). All procedures in the laboratory Environmental, Health and Safety Manual are followed during disposal. Samples are normally maintained in the laboratory no longer than 2 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.

Figure 24-1.

Chain of Custody (COC)

Chain of Custody Record

Temperature on Receipt _____

Drinking Water? Yes ☐ No ☐

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THE LEADER IN ENVIRONMENTAL TESTING

TAL-4124 (1007)

Client	Project Manager	Date	Chain of Custody Number 053963
Address	Telephone Number (Area Code)/Fax Number	Lab Number	Page _____ of _____
City / State / Zip Code	Site Contact / Lab Contact	Analysis (Attach list if more space is needed)	
Project Name and Location (State)	Carrier/Waybill Number		
Contract/Purchase Order/Quote No.			Special Instructions/ Conditions of Receipt

Sample I.D. No. and Description (Containers for each sample may be combined on one line)	Date	Time	Matrix: Air	Aqueous	Sed.	Soil	Containers & Preservatives: Unpres.	HNO3	H2SO4	HCl	NaOH	ZnAc/NaOH

Possible Hazard Identification
☐ Non-Hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown

Sample Disposal
☐ Return To Client ☐ Disposal By Lab ☐ Archive For _____ Months (A fee may be assessed if samples are retained longer than 1 month)

Turn Around Time Required
☐ 24 Hours ☐ 48 Hours ☐ 7 Days ☐ 14 Days ☐ 21 Days ☐ Other _____

QC Requirements (Specify)

1. Relinquished By	Date	Time	1. Received By	Date	Time
2. Relinquished By	Date	Time	2. Received By	Date	Time
3. Relinquished By	Date	Time	3. Received By	Date	Time

Comments

DISTRIBUTION: WHITE - Returned to Client with Report; CANARY - Stays with the Sample; PINK - Field Copy

Figure 24-2

TestAmerica Edison
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 preservation.
- 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 (when present)
- Apparent tampering with cooler and/or samples.
- Headspace in volatiles samples >6mm.
- 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 on the hardcopy COC and within the Sample Receipt application in TALS (the laboratory LIMS) and the client is contacted for instructions. If the client decides to proceed with the analysis, the project report will clearly indicate any of the above conditions and the resolution.

SECTION 25

ASSURING THE QUALITY OF TEST RESULTS *(NELAC 5.5.9)*

25.1 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.

25.2 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 and drying. 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.

25.3 NEGATIVE CONTROLS

Table 25-1. 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.).
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 25-1. 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. 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. (NELAC)
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.

25.4 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) 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.

25.4.1 Method Performance Control - Laboratory Control Sample (LCS)

25.4.1.1 The LCS measures the accuracy of the method in a blank matrix and assesses method performance independent of potential field sample matrix affects in a laboratory batch.

25.4.1.2 The LCS is prepared from a clean matrix similar to that of the associated samples that is free from target analytes (for example: Reagent water, Ottawa sand, glass beads, etc.) and is processed along with and under the same conditions as the associated samples. The LCS is spiked with verified known amounts of analytes or is made of a material containing known and verified amounts of analytes, taken through

all preparation and analysis steps along with the field samples. Where there is no preparation taken for an analysis (such as in aqueous volatiles), or when all samples and standards undergo the same preparation and analysis process (such as Phosphorus), a calibration verification standard is reported as the LCS. In some instances where there is no practical clean solid matrix available, aqueous LCS's may be processed for solid matrices; final results may be calculated as mg/kg or ug/kg, assuming 100% solids and a weight equivalent to the aliquot used for the corresponding field samples, to facilitate comparison with the field samples.

25.4.1.3 Certified pre-made reference material purchased from a NIST/A2LA accredited vendor may also be used for the LCS when the material represents the sample matrix or the analyte is not easily spiked (e.g. solid matrix LCS for metals, TDS, etc.).

25.4.1.4 The specific frequency of use for LCS during the analytical sequence is defined in the specific standard operating procedure for each analysis. It is generally 1 for each batch of samples; not to exceed 20 environmental samples.

25.4.1.5 If the mandated or requested test method, or project requirements, do not specify the spiking components, the laboratory shall spike all reportable components to be reported in the Laboratory Control Sample (and Matrix Spike) where applicable (e.g. no spike of pH). However, in cases where the components interfere with accurate assessment (such as simultaneously spiking chlordane, toxaphene and PCBs in Method 608), the test method has an extremely long list of components or components are incompatible, at a minimum, a representative number of the listed components (see below) shall be used to control the test method. The selected components of each spiking mix shall represent all chemistries, elution patterns and masses, permit specified analytes and other client requested components. However, the laboratory shall ensure that all reported components are used in the spike mixture within a two-year time period.

25.4.1.5.1 For methods that have 1-10 target analytes, spike all components.

25.4.1.5.2 For methods that include 11-20 target analytes, spike at least 10 or 80%, whichever is greater.

25.4.1.5.3 For methods with more than 20 target analytes, spike at least 16 components.

25.4.1.5.4 Exception: Due to analyte incompatibility in pesticides, Toxaphene and Chlordane are only spiked at client request based on specific project needs.

25.4.1.5.5 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.

25.5 SAMPLE MATRIX CONTROLS

Table 25-2. Example: 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;
	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.

25.6 ACCEPTANCE CRITERIA (CONTROL LIMITS)

25.6.1 As mandated by the test method and regulation, each individual analyte in the LCS, MS, or Surrogate Spike is evaluated against the control limits published in the test method. Where there are no established acceptance criteria, the laboratory calculates in-house control limits with the use of control charts or, in some cases, utilizes client project specific control limits. When this occurs, the regulatory or project limits will supersede the laboratory's in-house limits.

Note: For methods, analytes and matrices with very limited data (e.g., unusual matrices not analyzed often), interim limits are established using available data or by analogy to similar methods or matrices.

25.6.2 Once control limits have been established, they are verified, reviewed, and updated if necessary on an annual basis unless the method requires more frequent updating. Control limits are established per method (as opposed to per instrument) regardless of the number of instruments utilized.

25.6.3 Laboratory generated % Recovery acceptance (control) limits are generally established by taking $\pm$ 3 Standard Deviations (99% confidence level) from the average recovery of a minimum of 20-30 data points (more points are preferred).

25.6.3.1 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).

25.6.3.2 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.

25.6.3.3 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.

25.6.3.4 The maximum acceptable recovery limit will be 150%.

25.6.3.5 The maximum acceptable RPD limit will be 35% for waters and 40% for soils. The minimum RPD limit is 10%.

25.6.3.6 If either the high or low end of the control limit changes by $\leq$ 5% from previous, the control chart is visually inspected and, using professional judgment, they may be left unchanged if there is no affect on laboratory ability to meet the existing limits.

25.6.4 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.

25.6.4.1 The QA department generates Quality Control Limit Summaries in the form of Work Instructions that contain tables that summarize the precision and accuracy acceptability limits for analyses performed at TestAmerica Edison This summary includes an effective date, is updated each time new limits are generated and is located in the QAPUBLIC folder on the lab network F: drive. Unless otherwise noted, limits within these tables are laboratory generated. The analysts are instructed to use the current limits in the laboratory (dated and approved by the Technical Director and QA Manager) and entered into the Laboratory Information Management System

(LIMS). The Quality Assurance department maintains an archive of all limits used within the laboratory.

25.6.5 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 13) is also initiated if an LCS exceeds the acceptance limits. Sample results may be qualified and reported without reanalysis if:

25.6.5.1 The analyte results are below the reporting limit and the LCS is above the upper control limit.

25.6.5.2 If the analytical results are above the relevant regulatory limit and the LCS is below the lower control limit.

25.6.5.3 Or, for NELAC and Department Of Defense (DOD) work, there are an allowable number of Marginal Exceedances (ME):

- <11 analytes – 0 marginal exceedances are allowed.
- 11 – 30 Analytes – 1 marginal exceedance is allowed
- 31-50 Analytes – 2 marginal exceedances are allowed
- 51-70 Analytes – 3 marginal exceedances are allowed
- 71-90 Analytes – 4 marginal exceedances are allowed
- > 90 Analytes – 5 marginal exceedances are allowed

25.6.5.3.1 Marginal exceedances are recovery exceedances between 3 SD and 4 SD from the mean recovery limit (NELAC).

25.6.5.3.2 Marginal exceedances must be random. If the same analyte exceeds the LCS control limit repeatedly, it is an indication of a systematic problem. The source of the error must be located and corrective action taken. The laboratory has a system to monitor marginal exceedances to ensure that they are random.

25.6.5.3.3 Though marginal excedences may be allowed, the data must still be qualified to indicate it is outside of the normal limits.

25.6.6 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 13.

25.6.7 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). Under certain circumstances, where all of the samples are from the same location and share similar chromatography, the reanalysis may be performed on a single sample rather than all of the samples and if the surrogate meets the recovery criteria in the reanalysis, all of the affected samples would require reanalysis.

25.7 ADDITIONAL PROCEDURES TO ASSURE QUALITY CONTROL

25.7.1 The laboratory has written and approved method SOPs to assure the accuracy of the test method including calibration (see Section 21), use of certified reference materials (see Section 22) and use of PT samples (see Section 16).

25.7.2 A discussion regarding MDLs, Limit of Detection (LOD) and Limit of Quantitation (LOQ) can be found in Section 20.

25.7.3 Use of formulae to reduce data is discussed in the method SOPs and in Section 21.

25.7.4 Selection of appropriate reagents and standards is included in Section 10 and 22.

25.7.5 A discussion on selectivity of the test is included in Section 5.

25.7.6 Constant and consistent test conditions are discussed in Section 19.

25.7.7 The laboratories sample acceptance policy is included in Section 24.

SECTION 26

REPORTING RESULTS *(NELAC 5.5.10)*

26.1 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.

A variety of report formats are available to meet specific needs.

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 20.

26.2 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:

26.2.1 A report title (e.g. Analytical Report For Samples) with a "sample results" column header.

26.2.2 Each report cover page printed on company letterhead, which includes the laboratory name, address and telephone number.

26.2.3 A unique identification of the report (e.g. work order number) and on each page an identification in order to ensure the page is recognized as part of the report and a clear identification of the end.

Note: Page numbers of report are represented as page # of ##. Where the first number is the page number and the second is the total number of pages.

26.2.4 A copy of the chain of custody (COC).

- Any COCs involved with Subcontracting are included.

26.2.5 The name and address of client and a project name/number, if applicable.

26.2.6 Client project manager or other contact

26.2.7 Description and unambiguous identification of the tested sample(s) including the client identification code.

26.2.8 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.

26.2.9 Date reported or date of revision, if applicable.

26.2.10 Method of analysis including method code (EPA, Standard Methods, etc).

26.2.11 Reporting limit.

26.2.12 Method detection limits (if requested)

26.2.13 Definition of Data qualifiers and reporting acronyms (e.g. ND).

26.2.14 Sample results.

26.2.15 QC data consisting of method blank, surrogate, LCS, and MS/MSD recoveries and control limits.

26.2.16 Condition of samples at receipt including temperature. This may be accomplished in a narrative or by attaching sample login sheets (Refer to Sec. 26.2.4 – Item 3 regarding additional addenda).

26.2.17 A statement to the effect that the results relate only to the items tested and the sample as received by the laboratory.

26.2.18 A statement that the report shall not be reproduced except in full, without prior express written approval by the laboratory coordinator.

26.2.19 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.

26.2.20 When NELAC accreditation is required, the lab shall certify that the test results meet all requirements of NELAC or provide reasons and/or justification if they do not.

26.2.21 The laboratory includes a cover letter.

26.2.22 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.

26.2.23 When soil samples are analyzed, a specific identification as to whether soils are reported on a "wet weight" or "dry weight" basis.

26.2.24 Appropriate laboratory certification number for the state of origin of the sample, if applicable.

26.2.25 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.

26.2.26 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.

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.

26.2.27 <u>REPORTING LEVEL OR REPORT TYPE</u>

TestAmerica Edison offers several report formats. The packages provide the following information in addition to the information described above:

- Level I is a report with the features described in Section 26.2 above.
- Level II (also called 'Results/QA) is a Level I report plus summary information, including results for the method blank reported to the laboratory MDL, percent recovery for laboratory control samples and matrix spike samples, and the RPD values for all MSD and sample duplicate analyses.
- NJDEP Reduced Deliverables Format which contains, at minimum, the elements listed in the current NJDEP Technical Requirements for Site Remediation, N.J.A.C. 7:26E.
- NJDEP Full Deliverables Format (Non-USEPA CLP Methods) which contains, at minimum, the elements listed in the current NJDEP Technical Requirements for Site Remediation, N.J.A.C. 7:26E.
- NJDEP Full Deliverables Format (USEPA CLP Methods) which contains, at minimum, the elements listed in the current NJDEP Technical Requirements for Site Remediation, N.J.A.C. 7:26E.
- NYSDEC ASP 'A' and 'B' Deliverables Format which contain, at minimum, the elements listed in the current *New York State Department of Environmental Conservation Analytical Services Protocol*.

In addition to the various levels of QC packaging, the laboratory also provides reports in diskette deliverable form. Initial reports may be provided to clients by facsimile or email. All faxed or email reports are followed by hardcopy. Procedures used to ensure client confidentiality are outlined in Section 26.7.

26.2.28 Electronic Data Deliverables (EDDs)

EDDs are routinely offered as part of TestAmerica's services. TestAmerica Edison offers a variety of EDD formats including NJ Hazsite Deliverables, 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.

26.3 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.

26.3.1 Numeric results with values outside of the calibration range, either high or low are qualified as 'estimated'.

26.3.2 Where quality system requirements are not met, a statement of compliance/non-compliance with requirements and/or specifications is required, including identification of test results derived from any sample that did not meet NELAC sample acceptance requirements such as improper container, holding time, or temperature.

26.3.3 Where applicable, a statement on the estimated uncertainty of measurements; information on uncertainty is needed when a client's instructions so require.

26.3.4 Opinions and Interpretations - The test report contains objective information, and generally does not contain subjective information such as opinions and interpretations. If such information is required by the client, the Laboratory Director will determine if a response can be prepared. If so, the Laboratory Director will designate the appropriate member of the management team to prepare a response. The response 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.

Note: Review of data deliverable packages for submittal to regulatory authorities requires responses to non-conforming data concerning potential impact on data quality. This necessitates a limited scope of interpretation, and this work is performed by the QA Department. This is the only form of "interpretation" of data that is routinely performed by 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.

26.4 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 # 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.

26.5 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.

26.5.1 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 732-549-3900 (or for e-mails: please notify us immediately by e-mail or by phone (732-549-3900) and delete this material from any computer).

26.6 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.

26.7 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 13).

The revised report is retained on the Archive data server, as is the original report. The revised report is stored in the Archive data server under the original job number followed by "R". The revised report will have the word "REVISED" next to the report title (i.e., 'Laboratory Results – REVISED'). Any subsequent revisions will be filed on the server under the original job number followed by 'R' and a revision number (ex. R1, R2, R3).

When the report is re-issued, a notation of "REVISED "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.

26.8 POLICIES ON CLIENT REQUESTS FOR AMENDMENTS

26.8.1 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.

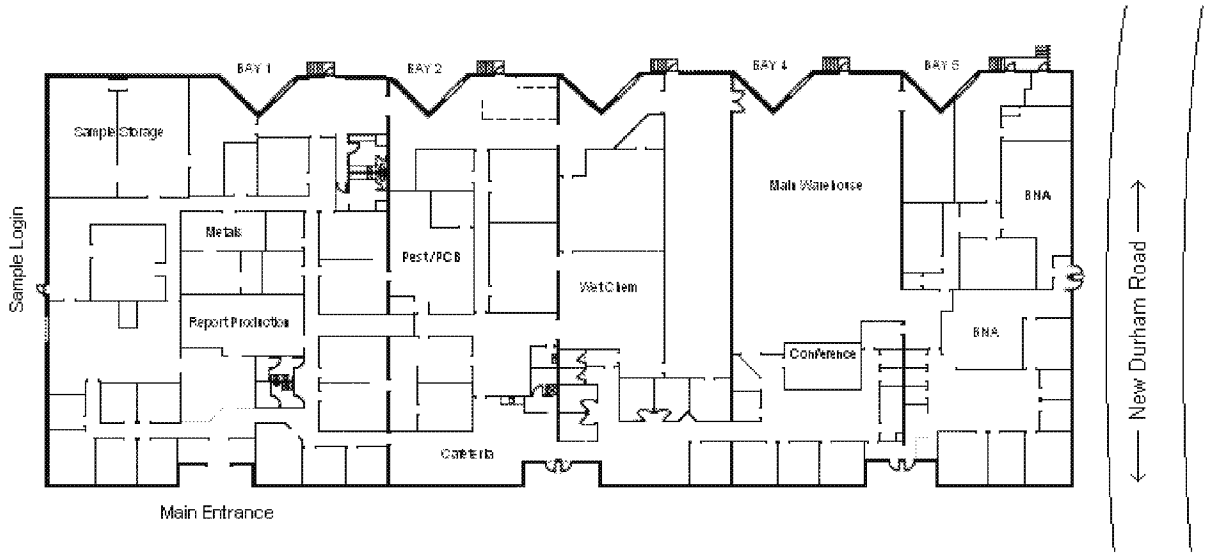
26.8.2 Multiple Reports

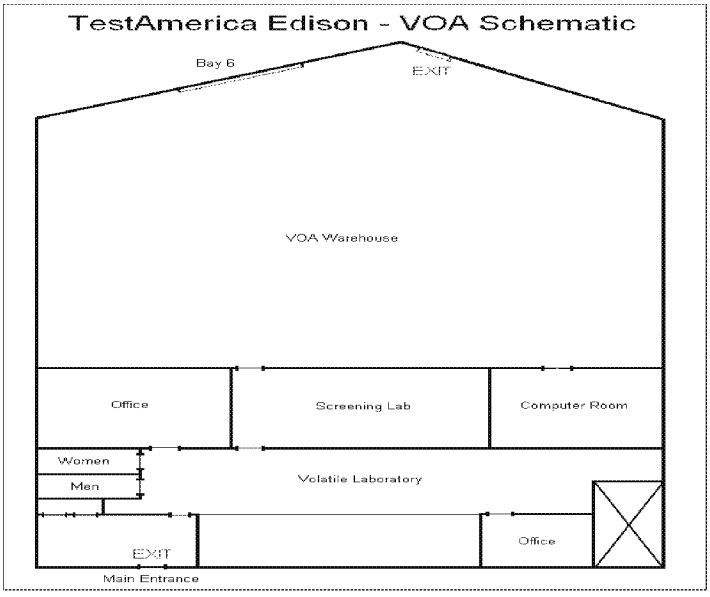
TestAmerica does not issue multiple reports for the same workorder where there is different information on each report (this does not refer to copies of the same report) unless required to meet regulatory needs and approved by QA.

Appendix 1.

Laboratory Floor Plan

TestAmerica Edison Facility Schematic





Appendix 2. Glossary/Acronyms

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. In the context of the National Environmental Laboratory Accreditation Program (NELAP), this process is a voluntary one. (NELAC)

Accrediting Authority:
The Territorial, State, or Federal Agency having responsibility and accountability for environmental laboratory accreditation and which grants accreditation (NELAC) [1.5.2.3]

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. (NELAC)

Batch:
Environmental samples which are prepared and/or analyzed together with the same process and personnel, using the same lot(s) of reagents. A preparation batch is composed of one to 20 environmental samples of the same matrix, meeting the above mentioned criteria and with a maximum time between the start of processing of the first and last sample in the batch to be 24 hours. An analytical batch is composed of prepared environmental samples (extracts, digestates or concentrates) and /or those samples not requiring preparation, which are analyzed together as a group using the same calibration curve or factor. An analytical batch can include samples originating from various environmental matrices and can exceed 20 samples. (NELAC Quality Systems Committee)

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)

Blind Sample:
A sample for analysis with a composition known to the submitter. The analyst/laboratory may know the identity of the sample but not its composition. It is used to test the analyst's or laboratory's proficiency in the execution of the measurement process.

Calibration:
To determine, by measurement or comparison with a standard, the correct value of each scale reading on a meter, instrument, or other device. The levels of the applied calibration standard should bracket the range of planned or expected sample measurements. (NELAC)

Calibration Curve:
The graphical relationship between the known values, such as concentrations, of a series of calibration standards and their instrument response. (NELAC)

Calibration Method:
A defined technical procedure for performing a calibration. (NELAC)

Calibration Standard:
A substance or reference material used to calibrate an instrument (QAMS)

Certified Reference Material (CRM):
A reference material one or more of whose property values are certified by a technically valid procedure, accompanied by or traceable to a certificate or other documentation which is issued by a certifying body. (ISO Guide 30–2.2)

Chain of Custody:
An unbroken trail of accountability that ensures the physical security of samples and includes the signatures of all who handle the samples. (NELAC) [5.12.4]

Clean Air Act:
The enabling legislation in 42 U>S>C> 7401 et seq., Public Law 91-604, 84 Stat. 1676 Pub. L. 95-95, 91 Stat., 685 and Pub. L. 95-190, 91 Stat., 1399, as amended, empowering EPA to promulgate air quality standards, monitor and enforce them. (NELAC)

Comprehensive Environmental Response, Compensation and Liability Act (CERCLA/SUPERFUND):
The enabling legislation in 42 U.S.C. 9601-9675 et seq., as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), 42 U.S.C. 9601 et seq., to eliminate the health and environmental threats posed by hazardous waste sites. (NELAC)

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. (NELAC)

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. NELAC 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
(NELAC)

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). (NELAC)

Data Reduction:
The process of transforming raw data by arithmetic or statistical calculations, standard curves, concentration factors, etc., and collation into a more useable form. (EPA-QAD)

Deficiency:
An unauthorized deviation from acceptable procedures or practices, or a defect in an item. (ASQC)

Detection Limit:
The lowest concentration or amount of the target analyte that can be identified, measured, and reported with confidence that the analyte concentration is not a false positive value. See Method Detection Limit. (NELAC)

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)

Environmental Detection Limit (EDL):
The smallest level at which a radionuclide in an environmental medium can be unambiguously distinguished for a given confidence interval using a particular combination of sampling and measurement procedures, sample size, analytical detection limit, and processing procedure. The EDL shall be specified for the 0.95 or greater confidence interval. The EDL shall be established initially and verified annually for each test method and sample matrix. (NELAC Radioanalysis Subcommittee)

Equipment Blank:
Sample of analyte-free media which has been used to rinse common sampling equipment to check effectiveness of decontamination procedures. (NELAC)

External Standard Calibration:
Calibrations for methods that do not utilize internal standards to compensate for changes in instrument conditions.

Federal Water Pollution Control Act (Clean Water Act, CWA):
The enabling legislation under 33 U.S.C. 1251 et seq., Public Law 92-50086 Stat 816, that empowers EPA to set discharge limitations, write discharge permits, monitor, and bring enforcement action for non-compliance. (NELAC)

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 Testing:
NELAC's approach to accrediting laboratories by program, method and analyte. Laboratories requesting accreditation for a program-method-analyte combination or for an up-dated/improved method are required to submit to only that portion of the accreditation process not previously addressed (see NELAC, section 1.9ff). (NELAC)

Holding Times (Maximum Allowable Holding Times):
The maximum times 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 and carried through the entire measurement process as a reference for evaluating and controlling the precision and bias of the applied analytical test method. (NELAC)

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)

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. 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), there is no LCS. 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.

Note: NELAC standards allow a matrix spike to be used in place of this control as long as the acceptance criteria are as stringent as for the LCS. (NELAC)

Laboratory Duplicate:
Aliquots of a sample taken from the same container under laboratory conditions and processed and analyzed independently. (NELAC)

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 of Detection (LOD):
An estimate of the minimum amount of a substance that an analytical process can reliably detect. An LOD is analyte- and matrix-specific and may be laboratory dependent. (Analytical Chemistry, 55, p.2217, December 1983, modified) See also Method Detection Limit.

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 matrix or Saline/Estuarine source. Includes surface water, groundwater, effluents, and TCLP or other extracts.

Drinking Water: any aqueous sample that has been designated as a potable or potential potable water source.

Saline/Estuarine: any aqueous sample from an ocean or estuary, or other salt water source such as the Great Salt Lake.

Non-aqueous Liquid: any organic liquid with <15% settleable solids.

Biological Tissue: any sample of a biological origin such as fish tissue, shellfish, or plant material. Such samples 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: 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. (NELAC)

Matrix Spike (spiked sample or fortified sample):

Prepared by adding a known mass of target analyte to a specified amount of matrix sample for which an independent estimate 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 spikes shall be performed at a frequency of one in 20 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 selected sample(s) shall be rotated among client samples so that various matrix problems may be noted and/or addressed. Poor performance in a matrix spike may indicate a problem with the sample composition and shall be reported to the client whose sample was used for the spike. (QAMS)

Matrix Spike Duplicate (spiked sample or fortified sample duplicate):
A second replicate matrix spike is prepared in the laboratory and analyzed to obtain a measure of the precision of the recovery for each analyte.

Matrix spike duplicates or laboratory duplicates shall be analyzed at a minimum of 1 in 20 samples per matrix type per sample extraction or preparation method. The laboratory shall document their procedure

to select the use of an appropriate type of duplicate. The selected sample(s) shall be rotated among client samples so that various matrix problems may be noted and/or addressed. Poor performance in the duplicates may indicate a problem with the sample composition and shall be reported to the client whose sample was used for the duplicate. (QAMS)

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. (NELAC)

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. (NELAC)

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. (NELAC)

Performance Based Measurement System (PBMS):
A set of processes wherein the data quality needs, mandates or limitations of a program or project are specified and serve as criteria for selecting appropriate test methods to meet those needs in a cost-effective manner. (NELAC)

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. (NELAC)

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. (NELAC)

Preservation:
Refrigeration and/or reagents added at the time of sample collection (or later) to maintain the chemical and/or biological integrity of the sample. (NELAC)

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. (NELAC) [2.1]

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. (NELAC)

Proficiency Test Sample (PT):
A sample, the composition of which is unknown to the analyst and is provided to test whether the analyst/laboratory can produce analytical results within specified acceptance criteria. (QAMS)

Quality Assurance:
An integrated system of activities involving planning, quality control, quality assessment, reporting and quality improvement to ensure that a product or service meets defined standards of quality with a stated level of confidence. (QAMS)

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 which purpose is to measure and control the quality of a product or service so that it meets the needs of users. (QAMS)

Quality Control Sample:
An uncontaminated sample matrix spiked with known amounts of analytes from a source independent from the calibration standards. 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. (EPA-QAD)

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. (NELAC)

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 (ANSI/ASQC-E-41994)

Quantitation Limits:
The maximum or minimum levels, concentrations, or quantities of a target variable (e.g., target analyte) that can be quantified with the confidence level required by the data user. (NELAC)

Range:
The difference between the minimum and the maximum of a set of values. (EPA-QAD)

Reagent Blank (method reagent blank):
A sample consisting of reagent(s), without the target analyte or sample matrix, introduced into the analytical procedure at the appropriate point and carried through all subsequent steps to determine the contribution of the reagents and of the involved analytical steps. (QAMS)

Reference Material:
A material or substance one or more properties of which are sufficiently well established to be used for the calibration of an apparatus, the assessment of a measurement method, or for assigning values to materials. (ISO Guide 30-2.1)

Reference Standard:
A standard, generally of the highest metrological quality available at a given location, from which measurements made at that location are derived. (VIM-6.0-8)

Replicate Analyses:
The measurements of the variable of interest performed identically on two or more sub-samples of the same sample within a short time interval. (NELAC)

Report Limit (RL):
The laboratory nominal Quantitation Limit (QL) or the level of sensitivity required by the client but not lower than the LOD.

Resource Conservation and Recovery Act (RCRA):
The enabling legislation under 42 USC 321 et seq. (1976), that gives EPA the authority to control hazardous waste from the "cradle-to-grave", including its generation, transportation, treatment, storage, and disposal. (NELAC)

Safe Drinking Water Act (SDWA):
The enabling legislation, 42 USC 300f et seq. (1974), (Public Law 93-523), that requires the EPA to protect the quality of drinking water in the U.S. by setting maximum allowable contaminant levels, monitoring, and enforcing violations. (NELAC)

Sample Duplicate:
Two samples taken from and representative of the same population and carried through all steps of the sampling and analytical procedures in an identical manner. Duplicate samples are used to assess variance of the total method including sampling and analysis. (EPA-QAD)

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:
(Analytical chemistry) the capability of a test method or instrument to respond to a target substance of constituent in the presence of non-target substances. (EPA-QAD)

Sensitivity:
The capability of a method or instrument to discriminate between measurement responses representing different levels (e.g., concentrations) of a variable of interest. (NELAC)

Spike:
A known mass of target analyte added to a blank, sample or sub-sample; used to determine recovery efficiency or for other quality control purposes.

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. 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, a representative number (at a minimum 10%) of the listed components may 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.. (NELAC)

Standard:
The document describing the elements of laboratory accreditation that has been developed and established within the consensus principles of NELAC and meets the approval requirements of NELAC procedures and policies. (ASQC)

Standard Operating Procedures (SOPs):
A written document which details the method of an operation, analysis, or action whose techniques and procedures are thoroughly prescribed and which is accepted as the method for performing certain routine or repetitive tasks. (QAMS)

Standardized Reference Material (SRM):
A certified reference material produced by the U.S. National Institute of Standards and Technology or other equivalent organization and characterized for absolute content, independent of analytical method. (EPA-QAD)

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)

Toxic Substances Control Act (TSCA):
The enabling legislation in 15 USC 2601 et seq., (1976) that provides for testing, regulating, and screening all chemicals produced or imported into the United States for possible toxic effects prior to commercial manufacture. (NELAC)

Traceability:
The property of a result of a measurement whereby it can be related to appropriate standards, generally international or national standards, through an unbroken chain of comparisons. (VIM-6.12)

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:

BS – Blank Spike
BSD – Blank Spike Duplicate
CAR – Corrective Action Report
CCV – Continuing Calibration Verification
CF – Calibration Factor
CFR – Code of Federal Regulations
COC – Chain of Custody
CRS – Change Request Form
DOC – Demonstration of Capability
DQO – Data Quality Objectives
DU – Duplicate
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
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
MDL – Method Detection Limit
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
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 Edison maintains certifications, accreditations, certifications, and validations with numerous state and national entities. Programs vary but may include on-site audits, reciprocal agreements with another entity, performance testing evaluations, review of the QA Manual, Standard Operating Procedures, Method Detection Limits, training records, etc. At the time of this QA Manual revision, the laboratory has accreditation/certification/licensing with the following organizations:

Organization	Certificate/Lab ID Number
New Jersey DEP	12028
Pennsylvania DEP	68-00522
Connecticut DPH	PH-2022
New York DOH	11452
Rhode Island DOH	LAO00132
Delaware DNRC	n/a
USDA Foreign Soils Permit	S-76543

The certificates and parameter lists (which may differ) for each organization may be found on the corporate web site, the laboratory's public server, the final report review table, and in the following offices: QA, marketing, and project management.

Title: SW846 Method 8260B, Volatile Organic Compounds By Gas Chromatography/Mass Spectrometry (GC/MS)

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Approvals (Signature/Date):

Sylvanus Klusey VOA Department Manager	09/14/11 Date	Kene' Kasperek Health & Safety Manager / Coordinator	09/14/11 Date
Carl Armbruster Quality Assurance Manager	09/14/11 Date	Ann Gladwell Laboratory Director	09/14/11 Date

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1.0 Scope and Application

1.1 Analytes, Matrix(s), and Reporting Limits

1.1.1 USEPA SW846 Method 8260 is used for the determination of volatile organic compounds in a variety of aqueous and solid matrices by purge and trap gas chromatography (GC)/mass spectrometery (MS). The method is applicable to the compounds listed in Table 1 (below). Actual target compound lists are determined through regulatory or project specifications. Method performance criteria for each target analyte will be determined prior to sample analysis.

1.1.2 This SOP also describes the optional procedure for analyses of compounds using Selected Ion Monitoring (SIM). SIM analyses is specific to target compounds: 1,2-dibromoethane, 1,2-dibromo-3-chloropropane and 1,4-Dioxane.

Table 1: Method Analytes

COMPOUND	CAS#	COMPOUND	CAS#
Acetone	67-64-1	Epichlorohydrin	106-89-8
Acetonitrile	75-05-8	Ethylbenzene	100-41-4
Acrolein (Propenal)	107-02-8	Ethyl methacrylate	97-63-2
Acrylonitrile	107-13-1	Fluorobenzene (IS)	462-06-6
Allyl alcohol	107-18-6	Hexachlorobutadiene	87-68-3
Benzene	71-43-2	2-Hexanone	591-78-6
Benzyl chloride	100-44-7	Iodomethane	74-88-4
Bromochloromethane	74-97-5	Isobutyl alcohol	78-83-1
Bromodichloromethane	75-27-4	Isopropylbenzene	98-82-8
4-Bromofluorobenzene (surr)	460-00-4	Ethyl Ether	60-29-7
Bromoform	75-25-2	Freon 113	76-13-1
Bromomethane	74-83-9	Methylene chloride	75-09-2
n-Butanol	71-36-3	Methyl methacrylate	80-62-6
2-Butanone (MEK)	78-93-3	4-Methyl-2-pentanone (MIBK)	108-10-1
t-Butyl alcohol	75-65-0	Naphthalene	91-20-3
Butyl Acrylate	141-32-2	Isoprene	78-79-5
Butyl Methacrylate	97-88-1	n-Butyl Acetate	123-86-4
Camphene	79-92-5	n-Propyl Acetate	109-60-4
Camphor	76-22-2	2-Octanol	4128-31-8
Carbon disulfide	75-15-0	1-Propanol	71-23-8
Carbon tetrachloride	56-23-5	2-Propanol(Isopropanol)	67-63-0
Chlorobenzene	108-90-7	n-Heptane	142-82-5
Chlorobenzene-d5 (IS)	3114-55-4	n-Hexane	110-54-3
Chlorodibromomethane	124-48-1	tert-Amyl methyl ether	994-05-8
Chloroethane	75-00-3	tert-Butyl ethyl ether	637-92-3
2-Chloroethyl vinyl ether	110-75-8	Styrene	100-42-5
Chloroform	67-66-3	1,1,1,2-Tetrachloroethane	630-20-6

COMPOUND	CAS#	COMPOUND	CAS#
Chloromethane	74-87-3	1,1,2,2-Tetrachloroethane	79-34-5
Dibromomethane	74-95-3	Tetrachloroethene	127-18-4
1,2-Dichlorobenzene	95-50-1	Toluene	108-88-3
1,3-Dichlorobenzene	541-73-1	Toluene-d8 (surr)	2037-26-5
1,4-Dichlorobenzene	106-46-7	Pentyl Acetate(Amyl Acetate)	628-63-7
1,4-Dichlorobenzene-d4 (IS)	3855-82-1	1,2,4-Trichlorobenzene	120-82-1
trans-1,4-Dichloro-2-butene	110-57-6	1,1,1 -Trichloroethane	71-55-6
Dichlorodifluoromethane	75-71-8	1,1,2-Trichloroethane	79-00-5
1,1-Dichloroethane	75-34-3	Trichloroethene	79-01-6
1,2-Dichloroethane	107-06-2	Trichlorofluoromethane	75-69-4
1,2-Dichloroethane-d4 (surr)	17060-07-0	1,2,3-Trichloropropane	96-18-4
1,1-Dichloroethene	75-35-4	Vinyl acetate	108-05-4
trans-1,2-Dichloroethene	156-60-5	Vinyl chloride	75-01-4
1,2-Dichloropropane	78-87-5	o-Xylene	95-47-6
cis-1,3-Dichloropropene	10061-01-5	m-Xylene	108-38-3
1,3-Dimethylnaphthalene	575-41-7	p-Xylene	106-42-3
Diethyl ether	60-29-7	Bromobenzene	108-86-1
1,4-Dioxane	123-91-1	n-Butylbenzene	104-51-8
Methyl acrylate	96-33-3	sec-Butylbenzene	135-98-8
Methyl-t-butyl ether	163-404-4	tert-Butylbenzene	98-06-6
Methyl Acetate	79-20-9	Methyl Cyclohexane	108-87-2
n-Propylbenzene	103-65-1	2-Octanone	111-13-7
1,2,3-Trichlorobenzene	87-61-6	4-Chlorotoluene	106-43-4
1,2,4-Trimethylbenzene	95-63-6	cis-1,2-Dichloroethene	156-59-2
1,3,5-Trimethylbenzene	108-67-8	1,3-Dichloropropane	142-28-9
Tetrahydrofuran	109-99-9	2,2-Dichloropropane	590-20-7
2-Methylnaphthalene	91-57-6	p-Isopropyltoluene	99-87-6
1,1,2-Trichloro-1,2,2-Trifluoroethane	76-13-1	Ethyl Acetate	141-78-6
		trans-1,3-Dichloropropene	10061-02-6
1-Propene	115-07-1	Ethanol	64-17-5
2-Chloropropane	75-29-6	Xylenes (total)	133-0207
1-Chloropropane	540-54-5	Isopropyl Ether (DIPE)	108-20-3
Dichlorofluoromethane	75-43-4	2-Ethyl-1-Hexanol	104-76-7
Methacrylonitrile	126-98-7	Propionitrile	107-12-0
2-Chloro-1,3-butadiene (chloroprene)	126-99-8	Ethyl methacrylate	97-63-2
Isobutyl Alcohol	78-83-1	2-Nitropropane	79-46-9
Cyclopentene	142-29-0	Indan	496-11-7

1.1.3 Method 8260 can be used to quantitate most volatile organic compounds that have boiling points below 200°C, and that are insoluble or slightly soluble in water. Water-soluble compounds can be included in this method, but quantitation limits will be higher due to poor purging efficiency.

1.1.4 The standard reporting limit (RL) is established at or above the low-level standard in the calibration curve. For a complete list of method

detection limits (MDLs) and RLs, please see reference the current TALS (LIMS) active Method Limit Group database.

1.1.5 On occasion clients may request modifications to this SOP. These modifications are handled following the procedures outlined in Sections 7 (*Review of Work Request*) and 20 (*Test Methods and Method Validation*) of TestAmerica Edison's Quality Assurance Manual (ED-QA-LQM).

2.0 Summary of Method

2.1 Method 8260 is used to determine volatile organic compounds in aqueous, non-aqueous and solid matrices. Sample preparation techniques vary, depending on the matrix and the level of contamination expected. Purge and trap techniques are used to introduce the sample to the GC/MS system. Refer to TestAmerica Edison SOP Nos. ED-MSV-001, *Purge and Trap for Aqueous Samples, SW846 Method 5030*, current revision and ED-MSV-002, *Closed-System Purge-and-Trap and Extraction for Volatile Organics in Soil and Waste Samples, SW846 Method 5035,* current revision.

2.2 All samples extracts are screened by GC/FID static headspace analysis to provide the analyst with appropriate initial dilution factors. For additional details see TestAmerica Edison SOP No. ED-GCV-001, *Screening for Volatile Organics, Static Headspace with GC FID, SW846 Method 5021*, current revision.

2.3 An aliquot of sample containing internal standard and surrogate spiking solution is purged with nitrogen in a closed sparging vessel. The volatile compounds are transferred from the aqueous phase to the vapor phase. The vapor is swept through a sorbent column where the volatiles are trapped. After purging is complete, the sorbent column is heated and backflushed with helium to desorb the volatiles onto a gas chromatograph column.

2.4 Analytes eluted from the capillary chromatograhy column are introduced into the mass spectrometer via a direct connection. Identification of target analytes is accomplished by comparing their mass spectra with the electron impact spectra of authentic standards. Quantitation is accomplished by comparing the response of a major (quantitation) ion relative to an internal standard using a minimum of a five-point calibration curve.

2.5 For aqueous VOA samples submitted for New Jersey Groundwater Quality Standard (NJ GWQS) evaluation, a full scan analysis is initially performed using the 8260 method. No further analysis by SIM is required if all of the following compounds are present above the full scan RL: 1,2-dibromoethane, 1,2-dibromo-3-chloropropane and 1,4-dioxane. If any of these compounds are undetected in the undiluted, full scan analysis, the sample must be analyzed via 8260 SIM for those compounds.

2.6 To meet lower reporting limits of 0.5ug/L for most analytes, 5ug/L for ketones and generally lower limits for other non-routine analytical compounds, spike at the appropriate levels using existing purging conditions. The corresponding TALS

login method for low level aqueous analysis is 8260_LL. See Table 3b for initial calibration levels and spike amounts.

3.0 Definitions

3.1 For a complete list of definitions refer to Appendix 2 in the most current revision of TestAmerica Edison's Quality Assurance Manual (ED-QA-LQM).

4.0 Interferences

4.1 This method is susceptible to contamination from a number of sources, including organic solvents used in other laboratory procedures, impurities in the purge gas, improper cleaning of syringes or purge vessels, and carryover from high level samples. Samples can be contaminated by the diffusion of volatile organics through the septum during shipment or storage. Steps have been taken to ensure that these potential problems are eliminated from the laboratory.

4.2 The volatiles analytical laboratory is housed in a separate building, away from the organic extraction lab area where large quantities of organic solvents are used. No organic solvents are used or stored in the volatiles laboratory.

4.3 The nitrogen used as purge gas passes through a solvent trap prior to its inlet into the purge and trap units.

4.4 A trip blank prepared from organic-free reagent water is carried through the sampling, storage and analysis of each group of samples to check for such contamination.

4.5 Individual samples are each handled with a unique syringe that has been baked in a drying oven at 105°C to ensure the absence of volatile compounds.

4.6 Purge vessels are removed from the autosampler units after each use, rinsed, baked, returned to the units and pre-purged before the next use.

4.7 Carryover can occur anytime a high level sample is analyzed. Screening procedures are employed to ensure that a sample is analyzed at an appropriate dilution to minimize potential carryover. When a high level sample is analyzed, it is followed by the analysis of a reagent water blank. If another sample was analyzed after the high level sample, this sample is inspected carefully for signs of carryover. If this sample does not contain any of the compounds found in the high level sample, the system can be considered contamination free.

4.8 The analytical system is checked daily with the analysis of a method blank. This blank must meet all quality control criteria for the method before sample analysis may take place.

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.

Any questions pertaining to safety issues or procedures should be brought to the department manager or Edison Safety Officer.

5.1 Specific Safety Concerns or Requirements

5.1.1 Latex, nitrile and vinyl gloves all provide adequate protection against the methanol used in this method.

5.1.2 Purge vessels on purge-and-trap instruments can be pressurized by the time analysis is completed. Vent the pressure prior to removal of these vessels to prevent the contents from spraying out.

5.1.3 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.

5.1.4 The mass spectrometer is under deep vacuum. The mass spectrometer must be brought to atmospheric pressure prior to working on the source.

5.1.5 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.

5.2 Primary Materials Used

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
Methanol (MeOH)	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.			

6.0 Equipment and Supplies

6.1 Instrumentation

6.1.1 Purge and trap units from several different manufacturers are used, depending upon the sample matrix and preparatory technique required. A purge and trap unit consists of three parts: the sample purge unit, the trap, and the concentrator. Unit configurations currently in use are:

- OI Analytical 4551 Automatic Sampler/4560 concentrator;
- Archon 5100A Automatic sampler/ OI Analytical 4660 concentrator;
- EST Centurion Autosampler/ EST Encon concentrator;
- Archon Autosampler/EST Encon concentrator.
- Archon/EST Evolution

6.1.2 A VOCARB 3000 trap from Supelco is used in the Encon concentrator. The trap is 25cm long with an inside diameter of 0.105 inches. The trap is packed with 10.0cm Carbopack B, 6.0 cm Carboxin 1000, and 1cm Carboxin 1001.

6.1.3 An OI analytical purge trap #10 is used for the OI 4560 concentrator. The trap is 25cm long with an inside diameter of 0.105 inches. The trap is packed to contain the following absorbents: Tenax/silica gel/carbon molecular sieve.

6.1.4 Alternate traps may be used provided the adsorption and desorption characteristics are equivalent to those of the trap recommended by the method.

6.1.5 Both the Encon and OI concentrators are capable of rapidly heating the trap to 260°C and holding at that temperature for the duration of the desorb time.

6.1.6 Gas chromatograph: HP 5890/Agilent 6890/7890 equipped with temperature programming capability.

6.1.7 GC column: 75M long x 0.53mm ID, J&W DB-624 capillary column with 3um film thickness, 20M x 0.18mm x 1um DB-624 and 20M long x 0.18 mm ID Restek Rtx-VMS capillary column with 1um film thickness or similar phase.

6.1.8 Mass Spectrometer (5971/5972/Agilent 5973/5975): scanning from 35-260 amu every 0.9 seconds, utilizing 70 volts (nominal) electron energy in the electron ionization mode and producing a mass spectrum which meets all EPA performance criteria when 50 ng of 4-Bromofluorobenzene (BFB) is injected through the gas chromatograph inlet.

6.1.9 GC/MS Interface: glass jet separator with fused silica transfer lines heated to 180°C or capillary direct.

6.1.10 Data system: HP Chemstation II for data acquisition and HP UNIX based TARGET software for data processing.

6.2 Supplies

- Microsyringes: 10 ul to 1000 ul.
- Syringes: 5 ml to 25 ml gas-tight.
- Injection port liners: HP 18740-80200 or equivalent
- Volumetric flasks: Class "A" glassware, 5 ml to 500 ml.
- VOA vials: 20-ml and 40-ml glass with PTFE – faced septum.
- Vials: 2-ml amber glass with screw cap with Teflon-faced septa.
- Top loading analytical balance.
- Spatula: Narrow, stainless steel.
- Stir bars: PTFE coated, small enough to spin freely inside a VOA vial.

7.0 Reagents and Standards

7.1 Reagents

7.1.1 Organic free reagent water: Distilled water purchased from Poland Spring or equivalent.

7.1.2 Methanol: Ultra Resi-Analyzed, purge and trap grade, purchased from JT Baker or equivalent. (Cat # 9077-02)

7.1.2.1 Each lot of methanol is screened for contaminants before being used for analysis as detailed in TestAmerica Corporate Quality SOP No. CA-Q-S-001 (*Solvent & Acid Lot Testing & Approval*) and TestAmerica Edison SOP No. ED-GEN-023 (*Bulk Solvent Testing and Approval*).

7.2 Standards

7.2.1 **Calibration Standards** Stock target compound analytical standard solutions are purchased mainly from Supelco, Inc, Absolute Standards and Spex although standards of similar quality from other suppliers may be substituted as required. Standards noted with an asterisk (*) are custom mixes made especially for TestAmerica Edison.

Target Analyte Standard Name	Concentration	Vendor	Catalog #
Gas Mix	2000 ppm	Supelco	48799U
Gas Mix (Second source)	2000 ppm	Supelco	4S8799U
8260 Mix 1 *	2000 ppm	Supelco	5-02111
8260 Mix 1 (Second source)*	2000 ppm	Supelco	5S02111
8260 Mix 5 *	2000 ppm	Supelco	86-1323
8260 Mix 5 (Second source) *	2000 ppm	Supelco	8S61323
8260 Mix 6 *	2000 ppm	Supelco	86-1309
8260 Mix 6 (Second source) *	2000 ppm	Supelco	8S61309
Alcohols *	50000 ppm (varied)	SPEX	VO-TANJ-4
Alcohols (Second source) *	50000 ppm (varied)	SPEX	VO-TANJ-4
2-Chlorethylvinylether *	2000 ppm	Supelco	86-1206
2-Chlorethylvinylether (Second source) *	2000 ppm	Supelco	8S61206
Ketone Mix	2000 ppm	Absolute	82402
Ketone Mix (note:in second source of 8260 mix 5) *	2000 ppm	Supelco	8S61323
Extra compound Mix *	20000ppm	Supelco	21391813
Extra Compound Mix (Second source) *	20000 ppm	SPEX	XQ-3840
Extra Compound Mix (Second source) *	2000 ppm	SPEX	VO-TANJ-8
Acrolein/Acrylonitrile/Dioxane (AC/AC)*	5000/2500/2500 ppm	SPEX	VO-TANJ-3
Acrolein/Acrylonitrile/Dioxane (AC/AC)* (Second source)	5000/2500/2500 ppm	SPEX	VO-TANJ-3
1,4-Dioxane	1000ppm	Absolute	70373
1,4-Dioxane (second source)	5000ppm	Absolute	93501
1,4-Dioxane	Neat	Sigma	360481
Propenes *	1000/2000ppm	Supelco	21240202
Propenes * (Second source)	1000/2000ppm	SPEX	XQ4113/ XQ4114
Freons*	1000ppm	SPEX	VO-TANJ-6
Cyclopentene	1000ppm	Absolute	70519
Cyclopentene (second source)	1000ppm	Absolute	70519
Indan	1000ppm	Absolute	70955
Indan (second source)	1000ppm	Absolute	70955
2-Nitropropane	1000ppm	Absolute	70461
2-Nitropropane (second source)	1000ppm	Absolute	70461

Target Analyte Standard Name	Concentration	Vendor	Catalog #
2-Chloro-1,3-butadiene (chloroprene)	1000ppm	Absolute	70483
2-Chloro-1,3-butadiene (chloroprene) SS	1000ppm	Absolute	70483
Methacrylonitrile	1000ppm	Absolute	70442
Methacrylonitrile (second source)	1000ppm	Absolute	70442
Propionitrile	1000ppm	Absolute	70349
Propionitrile (second source)	1000ppm	Absolute	70349
Ethyl methacrylate	1000ppm	Absolute	70381
Ethyl methacrylate (second source)	1000ppm	Absolute	70381
Isobutyl Alcohol	1000ppm	Absolute	70445
Isobutyl Alcohol (second source)	1000ppm	Absolute	70445

(1): The separate source for this material is not available as a distinct catalog number. Analyst must ensure that a separate lot of the material is selected and used as required.

An asterisk (*) indicates a custom standard mix.

7.2.1.1. Prepare stock solutions at volumes and concentrations indicated in Table 2 (Working Standards Preparation) by combining the indicated volumes of each stock solution into a volumetric flask corresponding to the total final volume. Dilute to the volume marker with methanol.

7.2.1.2. Prepare individual calibration standards as detailed in Section 9.2.2.1, Table 3, Initial Calibration Standards Preparation, Low Level Soil, and Table 3a, Initial Calibration Standards Preparation, Aqueous.

7.2.1.3. The 'Second Source' standards listed are used in the preparation of both the Initial Calibration Verification (ICV) standard (see Tables 4 and 4a for ICV preparation instructions) and the Laboratory Control Standard (LCS) (see Section 9.1.3 and Tables 4 and 4a).

7.2.2 **Surrogate Standards:** Surrogate standard solutions are prepared from the following individual neat compounds purchased from Sigma Aldrich:

Surrogate Standard Name	Concentration	Vendor	Catalog #
4-Bromofluorobenzene	Neat	Sigma Aldrich	B67201
Toluene-d8	Neat	Sigma Aldrich	151998
1,2-Dichloroethane-d4	Neat	Sigma Aldrich	396540

7.2.2.1 A primary surrogate stock solution (2500 ppm each) is prepared from the neat standards as follows:

Standard Name	Vendor	Catalog #	Volume added	Concentration of Stock Std.	Concentration of Standard	Total Volume Volume of MeOH
8260 1°Surrogate Mix: 4-Bromofluorobenzene Toluene-d8 1,2-Dichloroethane-d4	Sigma Aldrich	 B67201 151998 396540	 1585 ul 2678 ul 1932 ul	Neat	2500ppm	1000 ml

7.2.2.2 Secondary surrogate standard solutions are prepared at two (2) levels using the 2500 ppm primary stock solution as detailed in the table below:

Standard Name	Vendor	Catalog #	Volume added	Concentration of Stock Std.	Concentration of Standard	Total Volume Volume in MeOH/Total volume of MeOH
8260 Surrogate Mix: 4-Bromofluorobenzene Toluene-d8 1,2-Dichloroethane-d4	Sigma Aldrich	 B67201 151998 396540	4.0mL	2500ppm	500ppm	20mL 16mL TV/M
8260 Surrogate Mix: 4-Bromofluorobenzene Toluene-d8 1,2-Dichloroethane-d4	Sigma Aldrich	 B67201 151998 396540	400uL	2500ppm	50ppm	20mL 19.6mL TV/M

7.2.2.3 Methanol/Surrogate solution (2.5ug/mL): For methanol sampling field kits. Prepared by adding 1mL of 2500 ug/ml primary surrogate stock solution (see Section 7.2.2.1) to 1 L purge and trap grade methanol.

7.2.3 **Internal Standards:** Internal Standards Solutions are purchased from Supelco at two (2) concentration levels:

Standard Name	Concentration	Vendor	Catalog #
8260 Internal Standard Mix: *Chlorobenzene-d5 *1,4-Dichlorobenzene-d4 *Fluorobenzene	2500 ppm each	Supelco	86-1183
8260 Internal Standard Mix: *Chlorobenzene-d5 *1,4-Dichlorobenzene-d4 *Fluorobenzene	250 ppm each	Supelco	86-1184

7.2.4 **Internal Standard/Surrogate Mix (250 ppm each):** A solution containing both Internal Standards and Surrogates at 250 ppm is prepared in a 10ml volumetric flask as detailed below using the 2500 ppm surrogate stock solution prepared in Section 7.2.2.1 and the 2500 ppm internal standard mix detailed in Section 7.2.3:

Standard Name	Concentration of Stock Std.	Volume added to final volume of 10ml MeOH	Final Concentration of Standard
8260 Internal Standard/Surrogate Mix (250 ppm)	2500 ppm Surrogate Mix	1.0ml	250 ppm each component
	2500 Internal Std Mix (Supelco 86-1183)	1.0ml	

7.2.5 **Internal Standard/Surrogate Mix (SIM) (25 ppm each):** A solution containing both Internal Standards and Surrogates at 25 ppm is prepared in a 10ml volumetric flask as detailed below using the 2500 ppm surrogate stock solution prepared in Section 7.2.2.1 and the 2500 ppm internal standard mix detailed in Section 7.2.3:

Standard Name	Concentration of Stock Std.	Volume added to final volume of 10ml MeOH	Final Concentration of Standard
8260 Internal Standard/Surrogate Mix (25 ppm) (SIM)	2500 ppm Surrogate Mix	100ul	25 ppm each component
	2500 Internal Std Mix (Supelco 86-1183)	100ul	

7.2.6 **GC/MS Instrument Performance Check (BFB):** The instrument performance check solution consists of 4-Bromofluorobenzene in addition to the other two surrogates in methanol. Prepare the solution at 50ppm as specified in section 7.2.2.2. Assign an expiration date of 6 months.

7.2.7 All prepped standards are given a unique Lot# and all information pertaining to standard preparation is entered into the GC/MS VOA Standard Preparation Log Book. Information such as standard supplier, lot number, original concentration, a description of how the standard was made, are required along with the laboratory lot number, analyst's initials, date prepared, expiration date and verification signature. Class "A" volumetric must be used at all times and syringes, preferably gas-tight syringes when available, should be checked for accuracy using an analytical balance. Class "A" pipettes should also be used if volumes permit.

7.2.8 Please refer to TestAmerica Edison SOP No. ED-GEN-008, *Standard Operating Procedure for Preparation, Purity and Storage of Reagents and Standards*, current revision. For Method 8260:

- Shelf Life of Standard: Gas standards are replaced weekly. Non-gas standards must be replaced monthly.
- Storage Requirements: Stock standards are stored at 4°C and working standards stored at -10°C to -20°C.

8.0 Sample Collection, Preservation, Shipment and Storage

Sample container, preservation techniques and holding times may vary and are dependent on sample matrix, method of choice, regulatory compliance, and/or specific contract or client requests. Listed below are the holding times and the references that include preservation requirements.

Matrix	Sample Container	Min. Sample Size	Preservation	Holding Time	Reference
Waters	Glass 40 ml vials	40 mLs	HCl, pH < 2; Cool 4 °C ± 2°C	14 Days / preserved 7 Days / unpreserved	SW846 Method 5030
Soils (Low)	Encore or Terracore (40 ml vials)	5 grams in 5 mls DI H_2O	Frozen Stored -7°C to -20°C	14 Days	SW846 Method 5035
Soils (Med)	Encore or Terracore (40 ml vials)	5 grams in 10 mls MeOH	Cool 4 °C ± 2°C	14 Days	SW846 Method 5030
Soils (High)	Glass (Lab Prepared Kits)	10 grams in 25 mls MeOH	Cool 4 °C ± 2°C	14 Days	SW846 Method 5030

8.1 Storage blanks are prepared by filling 40 mL VOA vials with reagent water and placing one in each refrigerator. After one week, the storage blanks are removed and analyzed. Additional details can be found in TestAmerica Edison SOP No. ED-SPM-004, *Sample Storage & Handling Procedures for Mitigation of Sample and Laboratory Contamination,* current revision.

9.0 Quality Control

9.1 **Sample QC** - The following quality control samples are prepared with each batch of samples:

Quality Controls	Frequency	Control Limit
Method Blank (MB)	1 in 20 or fewer samples	< Rpt. Limit
Laboratory Control Sample (LCS)[1]	1 in 20 or fewer samples	Statistical Limits [4]
Matrix Spike (MS)[2]	1 in 20 or fewer samples	Statistical Limits [4]
MS Duplicate (MSD)[2]	1 in 20 or fewer samples	Statistical Limits [4]
Surrogates	every sample[3]	Statistical Limits [4]
Internal Standards	Every samples	Response within -50% to +100% of CCV

[1] LCS Duplicate (LCD) is performed only when insufficient sample is available for the MS/MSD or when requested by the client/project/contract.
[2] The sample selection for MS/MSD are randomly selected, unless specifically requested by a client….predetermined by the extraction lab.
[3] Analytical and QC samples (MB, LCS, MS/MSD)

[4] Statistical control limits are updated annually and are updated into LIMS.

9.1.1. **Method blanks** are analyzed every 12 hours immediately after successful calibration verification (ICV and CCV) and before any samples are analyzed during the 12 hour clock. Analyze the blank in the same manner as the associated samples.

9.1.1.1. Prepare an aqueous blank by filling a 40 mL vial with reagent water and placing it in the autosampler. The autosampler will add the internal standard and/or surrogate standard.

9.1.1.2. Prepare a medium or high level blank in a 50 mL volumetric flask by adding 1.0 mL of purge and trap grade methanol to reagent water and bringing up to volume with the reagent water. The appropriate volume of this mix is added to the purge vessel. The autosampler will automatically internal standard and/or surrogate standard.

9.1.1.3. Prepare a low- level soil blank in a 40 ml VOA vial by adding a magnetic stir bar and 5 ml of reagent water and placing the vial in the autosampler tray. An additional 5mL of reagent water plus 1uL of 250ppm Internal Standard/Surrogate Mix (see Section 7.2.4) will be added by the Archon prior to purging.

9.1.1.4. To be considered acceptable, the method blank must not have any target analytes above the reporting limit. If method blanks are unacceptably contaminated with target compounds that are also present in field samples, all affected samples must be re-extracted and re-analyzed. Corrective action must be taken to identify and eliminate the contamination source. Demonstrate that acceptable blanks can be obtained before continuing with sample extraction and analysis. Method blanks must be analyzed on each instrument on which the associated samples are analyzed.

9.1.1.5. Surrogate recoveries for the method blank must be within the laboratory generated limits. Internal standard area counts in the method blank must be within method specified limits. If any surrogate or internal standard is outside the limits, the method blank must re-analyzed.

9.1.2. **Matrix Spike (MS)/Matrix Spike Duplicate (MSD):** A matrix spike/matrix spike duplicate (MS/MSD) pair is extracted and analyzed with every 20 environmental samples of a specific matrix (defined as a sample batch which may contain up to 20 samples, and additional samples can be added to the batch for 14 days after the first sample was analyzed). Full compound list spiking is employed for MS/MSDs and LCSs. These spikes are prepared (as described in Section 9.1.2.1) concurrent with sample preparation. MS and MSD recoveries are calculated and compared to lab generated acceptance criteria which are updated annually. For acceptance

limits, reference the current TALS (LIMS) active Method Limit Group database.

9.1.2.1. Prepare the MS/MSD as follows:

9.1.2.1.1 Low Level Soil: The low level soil MS/MSD is prepared as detailed in the following table. This is prepared in duplicate (one for the MS, the other for the MSD) in a 5 ml syringe filled with reagent water. Once prepped the solution is added to separate 40 ml vials each containing 5 gram aliquots of the sample to be spiked :

Standard Solution (Reference Table 2, Lab Names)	Concentration	Volume of Standard (ul)Added to 5.0 ml of Reagent Water	Final Concentration (ug/kg)
8260 SP (Separate lot)	50ppm	2	20
MIX 3 SP (Separate lot)	5000ppm (varied)	2	3000 (varied)
GAS SP 2-Chlorethylvinylether (Separate lot)	50ppm	2	20
AC/AC/1,4-Dioxane (Separate lot)	500/250/250 ppm	3	300/150/150
Propenes (second source)	50ppm (varied)	2	20 (varied)

9.1.2.1.2 Aqueous Samples: The MS/MSD for aqueous samples is prepared as detailed in the following table. This is prepared in duplicate (one for MS, the other for MSD) in 50 ml volumetric flasks filled with an aliquot of sample to be spiked. Once prepped the solution is poured into a 40 ml VOA vial and loaded onto the purge and trap autosampler:

Standard Solution (Reference Table 2, Lab Names)	Concentration	Volume of Standard (ul) Added to 50 ml of Sample	Final Concentration (ug/L)
8260 SP (Separate lot)	50ppm	20	20
MIX 3 SP (Separate lot)	5000ppm (varied)	30	3000 (varied)
GAS SP 2-Chlorethylvinylether (Separate lot)	50ppm	20	20
AC/AC/1,4-Dioxane (Separate lot)	500/250/250 ppm	4	40/20/20
1,4-Dioxane	500ppm	13	130
Propenes (second source)	50ppm (varied)	20	20 (varied)

9.1.2.1.3 Medium & High Level Soils: The MS/MSD for medium/high level soils is prepared as detailed in the following table. This is prepared in duplicate (one for MS, the other for MSD) in 50 ml volumetric flasks filled with reagent water which has been previously spiked with the methanol sample extract. Once prepped the solution is poured into a 40 ml VOA vial, the and loaded onto the purge and trap autosampler:

Standard Solution (Reference Table 2, Lab Names)	Concentration	Volume of Standard (ul) Added to 50 ml of Reagent Water containing sample methanol extract	Final Concentration (ug/L)
8260 SP (Separate lot)	50ppm	20	20
MIX 3 SP (Separate lot)	5000ppm (varied)	30	3000 (varied)
GAS SP 2-Chlorethylvinylether (Separate lot)	50ppm	20	20
AC/AC/1,4-Dioxane (Separate lot)	500/250/250 ppm	4	40
1,4-Dioxane (separate lot)	500ppm	13	130
Propenes (second source)	50ppm (varied)	20	20 (varied)

9.1.2.1.4 SIM: The MS/MSD for SIM samples is prepared as detailed in the following table. This is prepared in duplicate (one for MS, the other for MSD) in 50 ml volumetric flasks filled with an aliquot of sample to be spiked. Once prepped the solution is poured into a 40 ml VOA vial and loaded onto the purge and trap autosampler:

Standard Solution	Concentration	Volume of Standard Added to 50 ml of Reagent Water (ul)	Final Concentration (ug/L)
8260 SP (Second source)	50ppm	0.5	0.50
1,4-Dioxane (second source)	500ppm (varied)	2	20
8260 IS/SS	25ppm	1	0.5

9.1.2.2. An Laboratory Control Sample (LCS) /Laboratory Control Sample Duplicate (LCSD) may be substituted for the MS/MSD if insufficient sample volume is available (see Section 9.1.3).

9.1.3. Laboratory Control Sample (LCS)/Laboratory Control Sample Duplicate (LCSD): A Laboratory Control Sample (LCS) (aka blank spike) must be prepared analyzed with each batch of 20 environmental samples. The LCS data is used to assess method performance if the MS/MSD recoveries fall outside of the lab generated limits (see For acceptance limits, reference the current TALS (LIMS) active Method Limit Group database). If the LCS recovery is within the current lab generated limits, the MS/MSD recoveries are attributed to matrix interference. If the LCS recovery results are outside the method specified, the LCS is reanalyzed. If, upon reanalysis, the LCS is it is still outside of limits the entire batch must be reanalyzed.

9.1.3.1 For LCS preparation instructions please refer to Section 9.2.1.1 for low level soil introduction technique (note: use reagent water only, no solid matrix is used when preparing the LCS) and Section 9.2.1.2 for aqueous/medium or high level solids introduction (note: use reagent water only, no sample or sample extract is used when preparing the LCS).

9.1.3.2 The LCS for SIM samples is prepared as detailed in the following table. This is prepared in a 50 ml volumetric flasks filled with organic free reagent water. Once prepped the solution is poured into a 40 ml VOA vial and loaded onto the purge and trap autosampler

Standard Solution	Concentration	Volume of Standard Added to 50 ml of Reagent Water (ul)	Final Concentration (ug/L)
8260 SP (Second source)	50ppm	0.5	0.50
1,4-Dioxane (second source)	500ppm	2	20
8260 IS/SS	25ppm	1	0.5

9.1.3.3 A Laboratory Control Sample Duplicate (LCSD) is analyzed only when insufficient client sample is available for preparation of an MS/MSD pair. The LCS/LSCD is evaluated in the same manner as the MS/MSD (see Section 9.1.2)

9.1.4. Surrogate Standards: All samples, blanks and QC samples are spiked with a three (3) component surrogate standard mix (see Section 7.2.2). The percent recovery of the surrogate standards is calculated and compared to lab generated limits (For acceptance limits, reference the current TALS (LIMS) active Method Limit Group database).

9.1.4.1. Surrogate recovery limits are lab generated and are updated annually.

9.1.4.2. Surrogate recoveries are calculated for the blank, samples, and QC samples. Surrogate recovery is calculated as:

$$\frac{\text{Concentration found}}{\text{Concentration added}} \times 100 = \%\ \text{RECOVERY}$$

9.1.4.3. If the surrogate recoveries of any blank, sample, or QC sample fails to meet the current recovery criteria, the sample must be re-analyzed. If a surrogate is diluted to a concentration below that of the lowest calibration standard, no corrective action is necessary

9.1.5. Internal Standards: All samples, blanks, standards and QC samples are spiked with a three (3) component internal standard mix (See Section 7.2.3). The response (area count) and retention time of each internal standard in all samples, standards, blanks and QC samples are monitored.

9.1.5.1. The internal standard responses must be within -50 +100% of its corresponding internal standard in the mid-level calibration standard or the active calibration curve. Failure to meet these criteria is indicative of sample matrix effects. All samples failing these criteria must be reanalyzed to confirm matrix effects.

9.1.5.2. Internal standard retention time is evaluated immediately after acquisition. The retention times of the internal standards must be within ±30 seconds of the internal standards from the mid point standard of the initial calibration or the calibration verification standard. Any blank, sample, or QC sample that fails to meet these criteria must be re-analyzed.

9.2 Instrument QC

9.2.1 GC/MS Instrument Performance Check (BFB): The GC/MS system is tuned using Perfluortributylamine (PFTBA) such that an injection or purging of 50ng of 4-Bromofluorobenzene (BFB) meets the abundance criteria listed in the table below. Prior to the analysis of any calibration standards or samples, the GC/MS system must meet all BFB key ion abundance criteria. This analysis will verify proper tuning of the system for a period of 12 hours post-injection. After 12 hours, the instrument performance must again be verified prior to the analysis of standards, QC or samples.

BFB Key Ions and Abundance Criteria	
Mass	**Ion Abundance Criteria**
50	15.0-40.0 percent of the base peak
75	30.0-60.0 percent of the base peak
95	Base peak, 100% relative abundance
96	5.0-9.0 percent of the base peak
173	Less than 2.0% of mass 174

BFB Key Ions and Abundance Criteria	
Mass	**Ion Abundance Criteria**
174	Greater than 50% of the base peak
175	5.0-9.0 percent of mass 174
176	Greater than 95.0% but less than 101% of mass174
177	5.0-9.0 percent of mass 176

9.2.1.1. The BFB mass spectrum may be evaluated using one of the procedures listed below. The spectrum may be background subtracted using a single peak no more than 20 scans before the peak apex. The BFB spectrum must meet the technical acceptance criteria listed in the table above:

- A single scan on the peak;
- An average of the peak;
- Use of three scan averaging and background subtraction techniques. Select the scan at the BFB peak apex, add +1 scan from the apex and -1 scans from the apex;

9.2.1.2. BFB parameter settings are stored in a tune file, which ill be used in all subsequent analysis of standards and samples.

9.2.2 Initial Calibration Range and Initial Calibration Verification

9.2.2.1. **Initial Calibration:** The initial calibration range consists of a five-point concentration (six points for second order regression) range of analytical standards prepared as described in Table 3/Table 3a (attached). The initial calibration range must be analyzed only after the BFB instrument performance check has met the criteria in Section 9.2.1. A separate initial calibration range is analyzed for each sample introduction technique.

9.2.2.2. If analysis by the SIM technique is required, prepare calibration standards for 1,2-dibromoethane and 1,2-dibromo-3-chloropropane at concentrations of 0.02, 0.05, 0.10, 0.50, 1.0 and 2.0ppb; 1,4-Dioxane at 2, 5, 10, 20, 30, 40. Add surrogates/internal to each point at a concentration of 0.5ppb. See Table 5 that summarizes the preparation information.

9.2.2.3. **Initial Calibration Verification (ICV):** An Initial Calibration Verification (ICV) standard is analyzed immediately after the Initial Calibration Range and before any samples are analyzed. The ICV is prepared as detailed in Section 7.2.1.3 and Tables 4 and 4a (full scan) and Table 5 (SIM) (attached). The ICV must be from a source separate from the standards used in the Initial Calibration Range.

9.2.3 Continuing Calibration Verification (CCV): A approximately mid-point (50 ug/ml and 0.50ug/ml for SIM) Continuing Calibration Verification (CCV) must be analyzed every 12 hours after the BFB instrument performance

check. The CCV is prepared as detailed in Section 7.2.1.1 and Table 3 (attached).

9.2.4 Calibration Acceptance Summary

9.2.4.1. **Retention Time:** The relative retention times of each compound in the five calibration standards must agree within 0.06 relative retention time units.

9.2.4.2. **Initial Calibration Range:** Internal standard calibration is employed for this method. After the initial calibration range has been analyzed as detailed in Section 10.3.3 the relative response factor (RRF) for each target/surrogate compound at each concentration level is determined using the following equation.

$$RRF = \frac{A_x}{A_{is}} \times \frac{C_{is}}{C_x}$$

Where:
A_x = Area characteristic ion for the compound (see attached Table 7)
Ais = Area characteristic ion of internal standard (see attached Table 7)
Cis = Concentration of internal standard
Cx = Concentration of compound in standard

9.2.4.2.1. Determine the mean RRF for each compound using the five RFs from the initial calibration range.

9.2.4.2.2. The average RFs of the five (5) System Performance Check Compounds (SPCCs) must meet the minimum RF criteria listed in the table below.

System Performance Check Compound (SPCC) Criteria	
SPCC	**Minimum RF**
Chloromethane	0.1
1,1-Dichloroethane	0.1
Bromoform	0.1
Chlorobenzene	0.3
1,1,2,2-Tetrachloroethane	0.3

9.2.4.2.3. Calculate the Standard Deviation (SD) and Percent Relative Standard Deviation (% RSD) of the response factors for each compound:

$$\% RSD = \frac{\text{Standard Deviation of RRFs}}{\text{Mean RRF}}$$

9.2.4.2.4. The % RSD of the six (6) Calibration Check Compounds (CCCs) listed in Table 9 (below) must be ≤30% in order

for the calibration range to be acceptable. If the %RSD for all CCCs is ≤15% linearity may be assumed. If the % RSD of any of the CCCs is ≥30% the calibration has failed and corrective action must be performed.

Calibration Check Compounds (CCCs)
1,1-Dichloroethene
Chloroform
1,2-Dichloropropane
Toluene
Ethylbenzene
Vinyl Chloride

9.2.4.2.5. For all compounds (including those analyzed by SIM) in order to assume linearity, the % RSD of the RRF's for each target analyte must be ≤15%.

9.2.4.2.6. If the above listed criteria is met, the system can be assumed to be linear, sample analysis may begin and the average RF from the initial calibration range may be used to quantitate all samples.

9.2.4.2.7. An alternative calibration technique may be employed for those any compounds exceeding the 15% RSD criteria:

9.2.4.2.7.1 **Linear regression**: Calculate the first order linear regression for any compound which did not meet the 15% RSD criteria. The r value (Correlation Coefficient) of the equation must be ≥0.99 for linear regression to be employed.

9.2.4.2.7.2 **Quadratic (or second order) regression**: may be used if the linear regression correlation coefficient exceeds criteria. Quadratic regression requires the use of a minimum six calibration points. If second order regression calibration is used, the r^2 (Correlation Coefficient) value must be ≥ 0.99

9.2.4.2.8. If neither of the alternative calibration techniques meets acceptance criteria, the calibration is no valid. Corrective action must be taken and the initial calibration range reanalyzed.

9.2.4.2.9. For additional detail refer to TestAmerica Edison Work Instruction No. EDS-WI-041, *8260B ICAL Procedure*, latest revision.

9.2.4.3. **Initial Calibration Verification (ICV):** Once the initial calibration has been analyzed and has met the above criteria, a

second source Initial Calibration Verification (ICV) (as prepared in Section 9.2.2.2) must be analyzed and evaluated. The ICV must meet the criteria of 80-120% recovery for all compounds however up to 20% of the compounds are allowed exceed this criteria as long as their recoveries are within 65-135%. If the criterion is not met, a second ICV may be analyzed after corrective measures are taken. If a second ICV analysis fails to meet criteria proceed with corrective action and the analysis of a new initial calibration range.

9.2.4.4. **Continuing Calibration Verification (CCV):** A CCV consisting of a standard at or near the midpoint of the Initial Calibration Range is analyzed every 12 hours of instrument operation or at the beginning of an analytical sequence to verify the initial calibration. The calibration verification consists of a BFB instrument performance check, and analysis of a calibration verification standard.

9.2.4.4.1 Tune Verification: Follow the procedure for verifying the instrument tune described in section 9.2.1 using a 50 ng injection of BFB. If the tune cannot be verified, analysis must be stopped, corrective action taken and a return to "control" demonstrated before continuing with the calibration verification process.

9.2.4.4.1.1 Calibration Verification: Analyze the calibration verification standard immediately after a BFB that meets criteria. Use the mid point calibration standard (50ug/L). **NOTE:** The same sample introduction technique employed for the initial six-point calibration must be used for the calibration verification.

9.2.4.4.1.2 Calculate response factors (RF) for each compound using the internal standard method.

9.2.4.4.1.3 The RFs of the four (5) System Performance Check Compounds (SPCCs) must meet the minimum RF criteria listed in Section 9.2.4.2.4.

9.2.4.4.1.4 Calculate the % Difference for each response factor in the calibration check standard vs. the response factors from the initial calibration.

9.2.4.4.1.5 If the percent difference/drift (%D) of the 6 calibration check compounds (CCC) is ≤20%, the initial calibration is assumed to be valid. If the ≤20% D criteria is not met for any one

CCC, corrective action/ investigation may be taken. After corrective action, another calibration verification standard may be injected. If the response for the analyte is still not ≤20%, a new initial calibration range is required.

9.2.4.4.1.6 If the CCCs were not among the project analytes (and therefore not included in the initial calibration), all target analytes must meet the 20% D criteria.

9.2.4.4.1.7 Percent drift is used instead of percent difference in calibrations employing either the linear or second order regression modes.

9.2.4.4.1.8 No one individual non-CCC compound of interest may exceed 50%D. For SIM analysis the %D is 50%.

9.2.4.4.1.9 The retention times of the internal standards from the calibration check must be within ±30 seconds of the internal standards from the mid point standard of the original calibration. If the retention time for any internal standard changes by more than 30 seconds from the latest daily (12 hour) calibration standard, the chromatographic system is inspected for malfunctions, and corrections made as required. If corrective action does not result in the retention time criteria being achieved, the system must be re-calibrated using four additional standards.

9.2.4.4.1.10 Internal standard area response is also evaluated immediately after acquisition. The response (area count) of each internal standard in the calibration verification standard must be within 50% - 100% of its corresponding internal standard in the mid-level calibration standard of the initial calibration curve. If the EICP area for any internal standard changes by more than a factor of two (-50% to +100%), the mass spectrometer system must be inspected for malfunction and corrections made as appropriate. When corrections are made, re-analysis of samples analyzed while the system was malfunctioning is required.

10.0 Procedure

10.1. Gas Chromatograph/Mass Spectrometer Operation

10.1.1. The instrument operating parameters are set as follows at the beginning of a method of analysis and remain constant throughout the entire analytical procedure

10.1.1.1 Full Scan Operating Mode

Purge and trap unit

Purge Time:	11 minutes
Dry Purge:	1 Minutes
Purge Gas:	Nitrogen
Purge Flow:	40-45 ml/min
Purge Temp:	Water: Ambient; Solids: 40°C
Trapping Temp:	Ambient, <30°C
Desorb Time:	1 Minute
Desorb Temp:	VOCARB: 260°C, #10: 190°C

Gas chromatograph

Injector:	180°C
Carrier Gas:	Helium
Carrier Flow:	6 ml/min, 6890: 0.8 ml/min
Oven Program:	40°C for 1 min, 8°C/min to 90°C, 20°C/ min to 250°C for 3 min; 6890: 40°C for 1 min, 8°C/min to 100°C, 24°C/min to 220°C for 2 min
Run Time:	15 - 20 Minutes

Mass Spectrometer

Electron Energy:	70 volts (nominal)
Mass range:	35-260 AMU
Scan time:	0.9 sec./scan
Source Temp:	200°C
Separator Temp:	180°C

10.1.1.2 SIM Operating Mode

Purge and trap unit

Purge Time:	11 minutes

Dry Purge:	1 Minutes
Purge Gas:	Nitrogen
Purge Flow:	40-45 ml/min
Purge Temp:	Water: Ambient; Solids: 40°C
Trapping Temp:	Ambient, <30°C
Desorb Time:	1 Minute
Desorb Temp:	VOCARB: 260°C, #10: 190°C

Gas chromatograph

Injector:	180°C
Carrier Gas:	Helium
Carrier Flow:	6 ml/min, 6890: 0.8 ml/min
Oven Program:	40°C for 1 min, 8°C/min to 90°C, 20°C/ min to 250°C for 3 min; 6890: 40°C for 1 min, 8°C/min to 100°C, 24°C/min to 220°C for 2 min
Run Time:	15 - 20 Minutes

Mass Spectrometer

Electron Energy:	70 volts (nominal)
Mass range:	35-260 AMU
Scan time:	0.9 sec./scan
Source Temp:	200°C
Separator Temp:	180°C

SIM Parameters:

Group 1
Plot 1 Ion: 51.0/96

Ions/Dwell in Group	(Mass	Dwell)	(Mass	Dwell)	(Mass	Dwell)
	51.0	100	58.0	100	65.0	100
	67.0	100	70.0	100	88.0	100
	96.0	100				

Group 2
Group Start Time: 6.20
Plot 1 Ion: 82/117

Ions/Dwell in Group	(Mass	Dwell)	(Mass	Dwell)	(Mass	Dwell)
	82.0	100	107.0	100	109.0	100
	117.0	100				

Group 3
Group Start Time: 8.50
Plot 1 Ion: 75/157

Ions/Dwell in Group	(Mass	Dwell)	(Mass	Dwell)	(Mass	Dwell)
	75.0	100	95.0	100	150.0	100
	152.0	100	152.0	100	157.0	100
	174.0	100				

10.2. Sample Preparation

10.2.1. Screening: All samples extracts must be screened by GC/FID static headspace analysis to provide the analyst with appropriate initial dilution factors. For additional details see TestAmerica Edison SOP No. ED-GCV-001, *Screening for Volatile Organics, Static Headspace with GC FID, SW846 Method 5021*, current revision.

10.2.2. Aqueous Samples: Unopened 40 mls vials with aqueous samples are placed in an Archon autosampler. 1 uL of Internal Standard/Surrogate Mix (see Section 7.2.4) is added by the Archon as the 5 mL of the sample passes through the sample loop.

10.2.3. Medium or high level soils: Medium or high level extracts that will be run on an Archon autosampler are prepared in 50mL volumetric flasks. The Archon can be set up to add 1uL of 250ppm Internal Standard/Surrogate Mix (see Section 7.2.4) to each sample as the 5mL portion passes through the sample loop.

10.2.4. Low level soils: Low level soils must be run on an Archon autosampler. 1uL of 250ppm Internal Standard/Surrogate Mix (see Section 7.2.4) and 5mL reagent water is added to each sample vial by the Archon immediately before the sample is purged.

10.3. Instrument Performance and Calibration Sequence

10.3.1. Once the GC/MS instrument has been setup and maintained as detailed in Section 10.1, the first operations to be performed are the performance checks and calibration standards.

10.3.2. Analyze the Instrument Performance Check Standard (BFB) as discussed in Section 9.2.1.

10.3.3. A unique initial calibration is then prepared for each sample introduction technique.:

10.3.3.1 40 ml VOA Vial (Aqueous/Medium-High Level Soils): Prepare aqueous calibration standards at six concentration levels for each parameter by adding the volumes of working standards listed in Table 3 to a 50mL volumetric flask of reagent water. Pour the calibration standards into 40mL VOA vials and load into the autosampler tray. If the internal standard is to be added by the Archon/OI autosamplers the addition of internal standard into the 50ml volumetric flaks may be omitted.

10.3.3.2 40 ml VOA Vial (Low Level Soils): If the calibration is for low-level soils prepared according to Method 5035, the calibration

standards must be prepared by adding the volumes of working standards listed in Table 3 into a 5 mL syringe filled with reagent water and pouring the prepared standards into 40 mL VOA vials containing a magnetic stir bar.

10.3.4. Purge the standard for 11 minutes.

10.3.5. After purging is complete, desorb the sample onto the GC column by rapidly heating the trap to 260°C for VOCARB, 190°C for #10 and backflushing it with helium.

10.3.6. Begin the GC temperature program and data acquisition.

10.3.7. Re-condition the trap by baking for 12 minutes at 260°C for VOCARB, 210°C for #10.

10.3.8. Cool the trap to (<31°C). The trap is now ready for the next sample.

10.3.9. Transfer data to network, and process using TARGET software.

10.4. Sample Analysis Sequence

10.4.1. Once the initial calibration has been verified by successful analysis of an ICV and Method Blank, analysis of samples may begin.

10.4.2. Samples must be analyzed under the same instrument conditions and using the same injection volume as the calibration standards.

10.4.3. Equilibrate all samples to room temperature prior to analysis.

10.4.4. If the sample concentration exceeds that of the range, the sample must be diluted and re-analyzed.

10.4.5. The analytical run log is printed as a record of samples analyzed. The analyst will annotate the run log with any required information regarding anomalies or unusual events. The run log must be signed by the analyst and a reviewed and signed by a trained peer or manager

10.5. Data Processing

10.5.1. Prior to processing any standards or samples, target compound lists and sublists must be assembled in the Target system. These lists are required for processing of all data files including calibration files. The data includes compound names, retention time data, quantitation ions, qualitative identification ions, and the assigned internal standard for qualitative and quantitative identification.

10.5.2. Key data is manually entered the first time a compound list is used for data processing. Processing data using a compound list automatically generates response factor data and updates retention information.

10.5.3. Data is transferred from the acquisition PC to the network for processing with TARGET software.

10.5.4. Each data file is checked for correct information including sample number, job number, QA batch, dilution factor, initial volume, final volume, and % moisture.

10.5.5. Each sample is checked against a department work list for the correct sublist of target analytes.

10.5.6. Each data file is processed using calibration factors from the most recent initial calibration, quantitation from the daily calibration verification standard is not permitted.

10.5.7. The characteristic ions for target compounds, surrogate compounds, and internal standards which can be determined using SW8260B are listed in Table 7.

10.6. Interpretation and Qualitative Identification:

10.6.1 Target Analytes: Qualitative identification of target compounds is based on retention time and mass spectral comparison with characteristic ions in the target compound list. The reference mass spectrum is taken from a standard of the target compound analyzed by this method. The characteristic ions are 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:

10.6.1.1. Once the GC/MS instrument has been setup and maintained as detailed in Section 10.1, the first operations to be performed are the performance checks and calibration standards.

10.6.1.2. The intensities of the characteristic ions of a compound maximize in the same scan or within one scan of each other.

10.6.1.3. The relative retention time (RRT) of the sample component is within ± 0.06 RRT units of the RRT of the standard component.

10.6.1.4. The most abundant ion in the standard target spectrum that equals 100% MUST also be present in the sample target spectrum.

10.6.1.5. All other ions that are greater than 10% in the standard target spectra should also be present in the sample.

10.6.1.6. 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%).

10.6.1.7. Structural isomers that produce very similar mass spectra should be identified as individual isomers if they have sufficiently different GC retention times. Otherwise, structural isomers are identified as isomeric pairs.

10.6.1.8. If the compound does not meet all of the criteria listed above, but is deemed a match in the technical judgment of the mass spectral interpretation specialist, the compound will be positively identified and reported with documentation of the identification noted in the raw data record.

10.6.2 Non-Target Analytes: Upon client request a library search to identify non-target Tentatively Identified Compounds (TIC) is performed. The NIST/EPA/NIH mass spectral library is used to identify non-target compounds (not including internal standard and surrogate compounds) of greatest apparent concentration by a forward search of the library. The following guidelines are used by the analyst when making TIC identifications:

10.6.2.1 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.

10.6.2.2 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%).

10.6.2.3 Molecular ions present in the reference spectrum should be present in the sample spectrum.

10.6.2.4 Ions present in the sample spectrum but not in the reference spectrum should be reviewed for possible background contamination or presence of co-eluting compounds.

10.6.2.5 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 co-eluting peaks. Data system library reduction programs can sometimes create these discrepancies.

10.6.2.6 If, in the technical judgement of the mass spectral interpretation specialist, no tentative identification can be made, the compound will be reported as 'Unknown'. If the

compound can be further classified the analyst may do so (i.e, 'Unknown hydrocarbon', 'Unknown acid' , etc..).

10.7. Data Reporting

10.7.1. Final Report. The Target system automatically produces a data report consisting of key, hardcopy reports corresponding to specific data reporting requirements. Standard reports consist of multiple pages that the analysts must compile and organize for the report production group.

10.7.1.1. Total Ion Chromatogram. Full length chromatogram depicting the full length of the GC/MS acquisition.

10.7.1.2. Spectra of all detected target compounds. A page for each detected target compound spectra with a standard reference spectrum for comparison.

10.7.1.3. The calculations of the concentrations of each target compound in the sample, reported in units of ppb, ug/kg or ug/l.

10.7.1.4. Data summaries for each method blank indicating which samples were extracted with the indicated blank.

10.7.1.5. A copy of the initial calibration range together with the calibration verification report, and tune report.

10.7.1.6. Quality Control (QC) data report for each batch including surrogate recoveries, internal standard area summaries, LCS, MS/MSD and RPD summaries.

11.0. Calculations / Data Reduction

11.1. Target Compounds: are quantitated using the internal standard method.

11.1.1. Identified target compounds are quantitated using the integrated abundance from the EICP of the primary characteristic ion. The internal standard used shall be the one nearest the retention time of the analyte).

11.1.2. The average response factor (RRF) from the initial calibration is used to calculate the target analyte concentration in client samples using the formula found in Section 11.3.. See Section 9.2.4.2 for discussion of RRF.

11.1.3. Secondary ion quantitation is utilized only when there are sample interferences preventing use of the primary characteristic ion. If secondary ion quantitation is used an average relative response factor (RRF) must be calculated using that secondary ion.

11.1.4. Aqueous Samples

$$\text{Concentration } (\mu g/L) = \frac{(As)(Cis)(D)}{(Ais)(RRF)(Vs)}$$

Where:

As	=	Area of the characteristic ion for the target analyte in the sample
Cis	=	Concentration of the internal standard (ug/L)
D	=	Dilution factor, if the sample or extract was diluted prior to analysis. If no dilution is performed, D = 1.
Ais	=	Area of the characteristic for the associated internal standard
RRF	=	Average relative response factor from the initial calibration.
Vs	=	Volume of sample purged (ml)

11.1.5. Low Level Solid Samples

$$\text{Concentration } (\mu g/Kg) \text{ (dry wt)} = \frac{(As)(Cis)}{(Ais)(RRF)(Ws)\ (DW)}$$

Where:

As	=	Area of the characteristic ion for the target analyte in the sample
Cis	=	Concentration of the internal standard (ug/L)
DW	=	Dry wt correction = $\frac{100 - \%\ \text{moisture}}{100}$
Ais	=	Area of the characteristic for the associated internal standard
RRF	=	Average relative response factor from the initial calibration.
Ws	=	Weight of sample purged (g)

11.1.6. Medium Level Solid Samples

$$\text{Concentration } (\mu g/Kg) \text{ (dry wt)} = \frac{(As)(Cis)(Vt)(1000)(D)}{(Ais)(RRF)(Va)(Ws)(DW)}$$

Where:

As	=	Area of the characteristic ion for the target analyte in the sample
Cis	=	Concentration of the internal standard (ug/L)
D	=	Dilution factor, if the sample or extract was diluted prior to analysis. If no dilution is performed, D = 1
DW	=	Dry wt correction = $\frac{100 - \%\ \text{moisture}}{100}$
Ais	=	Area of the characteristic for the associated internal standard
RRF	=	Average relative response factor from the initial calibration.
Va	=	Volume of the aliquot of sample methanol extract added to reagent water for purging in ul
Vt	=	Total volume of methanol extract in milliliters
Ws	=	Weight of sample purged (g)

11.2. Non-Target Compounds (Tentatively Identified Compounds): An estimated concentration for non-target (tentatively identified compounds) is calculated using the internal standard method . For quantiation, the nearest eluting internal standard free of interferences is used. The procedure used for calculating the concentration of non-target compounds is the same as that used for target compounds (see Section 11.1) with the following revisions:

11.2.1. The total area count of the non-target compound is used for As (instead of the area of a characteristic ion).

11.2.2. The total area count of the chosen internal standard is used as Ais (instead of the area of a characteristic ion).

11.2.3. A RF on 1.0 is assumed.

11.2.4. The resulting concentration is qualified as estimated ('J') indicating the quantitative uncertainties of the reported concentration.

11.3. Relative Response Factors

$$RRF = \frac{A_x}{A_{is}} \times \frac{C_{is}}{C_x}$$

Where:

A_x = Area characteristic ion for the compound (see Table 7)
Ais = Area characteristic ion of associated internal standard (See Table 7)
Cis = Concentration of internal standard
Cx = Concentration of compound in standard

11.4. Percent Relative Standard Deviation (% RSD) : as discussed in Section 9.2.4.2. (Initial calibration):

$$\% \text{ RSD} = \frac{\text{Standard Deviation of RRFs}}{\text{Mean RRF}}$$

11.5. Percent Difference (% D):as discussed in Section 9.2.4.4 (Continuing calibration):

$$\% \text{ D} = \frac{RRF_c - \overline{RRF_i}}{\overline{RRF_i}} \times 100$$

Where: RRFc = RRF from continuing calibration

$\overline{RRF_i}$ = Mean RRF from current initial calibration

11.6. Percent Recovery (% R): Surrogates and Spikes

$$\text{Recovery (\%)} = \frac{\text{Concentration (or amount) found}}{\text{Concentration (or amount) added}} \times 100$$

11.7. Dry Weight Correction: All solid samples must be corrected for dry weight using the following formula for dry weight determination.

$$DW = \frac{Gd}{Gw} \times 100$$

Where:

DW	=	Percent % Dry Weight
Gd	=	Dry weight of selected sample aliquot
Gw	=	Wet weight of selected sample aliquot

Multiply the DW value times the wet weight of the sample extracted. NOTE: This calculation can also be performed automatically by the target system provided the DW value is available and entered into the system.

11.8. Accuracy:

$$\text{ICV , CCV and LCS \% Recovery} = \frac{\text{observed concentration}}{\text{known concentration}} \times 100$$

$$\text{MS \% Recovery} = \frac{\text{(spiked sample) - (unspiked sample)}}{\text{spiked concentration}} \times 100$$

11.9. Precision (RPD):

$$\text{Matrix Duplicate (MD)} = \frac{|\text{orig. sample value - dup. sample value}|}{[(\text{orig. sample value + dup. sample value})/2]} \times 100$$

12.0 Method Performance

12.1. Method Detection Limit Study (MDL)

The method detection limit (MDL) is the lowest concentration that can be detected for a given analytical method and sample matrix with 99% confidence that the analyte is present. The MDL is determined according to the laboratory's MDL procedure in Section 20 (Test Methods and Method Validation) of TestAmerica Edison's Quality Assurance Manual (ED-QA-LQM). MDLs reflect a calculated (statistical) value determined under ideal laboratory conditions in a clean matrix, and may not be achievable in all environmental matrices. The laboratory maintains MDL studies for analyses performed; these are verified at least annually unless method requirements require a greater frequency.

12.2. Demonstration of Capabilities

For DOC procedure refer to Section 20 in the most current revision of TestAmerica Edison's Quality Assurance Manual (ED-QA-LQM).

12.3. Training Requirements

Refer to TestAmerica Edison SOP No. ED-GEN-022, *Training*, current revision for the laboratory's training program.

13.0 Pollution Control

13.1. 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 Environmental Health and Safety Manual (CW-E-M-001) for "Waste Management and Pollution Prevention."

14.0 Waste Management

14.1. 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 TestAmerica Edison SOP No. ED-SPM-008, *Laboratory Waste Disposal Practices*, current revision. The following waste streams are produced when this method is carried out.

- Laboratory Generated Aqueous Waste (aqueous VOA vials – used and unused). This waste may have a pH of less than 2.0. These vials are collected in satellite accumulation. The vials are then transferred to the waste room. These vials are passed through a vial crusher and the liquid portion is separated from the solid portion. The solid is dumped into the municipal garbage. The liquid is pumped into the neutralization system where it is neutralized to a pH of 6 to 9 with sodium bicarbonate (Seidler Chemical SC-0219-25). When neutralization is complete, the material is transferred to the municipal sewer system.

- Expired Standards – The vials are collected in a 1 gallon polyethylene bucket. These vials are then transferred to an open top 55 gallon steel or polyethylene waste drum. These drums are transported to a waste facility for proper disposal.

- Soil Retain Samples - These samples if not flagged in the system for any hazardous constituents are transferred to poly-lined cubic yard boxes. These boxes when full are sent to stabilization or incineration. These materials are sent out as hazardous for lead and chromium

  Teris Profile Number (incineration): 50016710
  Onyx Profile Number: (stabilization) 402535

- Methanol Preserved Samples/Returned Methanol Preservative - Methanol preserved sample vials are collected in satellite accumulation and then transferred to a 55 gallon open top steel waste drum in the waste room. This drum is then removed by a waste vendor for incineration.

  Teris Profile Number: 50016652
  Onyx Profile Number: 282493

15.0 References / Cross-References

15.1. United States Environmental Protection Agency, "Method SW8260B, Volatile Organic Compounds by Gas Chromatography/Mass Spectrometry (GC/MS)", Test Methods for Evaluating Solid Wastes, SW846 Third Edition, Volume 1B: Laboratory Manual, Physical/Chemical Methods, Revision 2, December 1996.

15.2 United States Environmental Protection Agency, "Method SW8000B: Determinative Chromatographic Separations", Test Methods for Evaluating Solid Wastes, SW846 Third Edition, Volume 1B: Laboratory Manual, Physical/Chemical Methods, Revision 3, December 1996.

15.3 TestAmerica Edison Document No. ED-QA-LQM, *Laboratory Quality Manual*, most current revision.

15.4 TestAmerica Edison SOP Nos. ED-MSV-001, *Purge and Trap for Aqueous Samples, SW846 Method 5030*, current revision.

15.5 TestAmerica Edison ED-MSV-002, *Closed-System Purge-and-Trap and Extraction for Volatile Organics in Soil and Waste Samples, SW846 Method 5035,* current revision.

15.6 TestAmerica Edison SOP No. ED-GCV-001, *Screening for Volatile Organics, Static Headspace with GC FID, SW846 Method 5021*, current revision.

15.7 TestAmerica Corporate Quality SOP No. CA-Q-S-001, *Solvent & Acid Lot Testing & Approval*, current revision.

15.8 TestAmerica Edison SOP No. ED-GEN-023, *Bulk Solvent Testing and Approval*, current revision.

15.9 TestAmerica Edison SOP No. ED-GEN-008, *Standard Operating Procedure for Preparation, Purity and Storage of Reagents and Standards*, current revision

15.10 TestAmerica Edison SOP No. ED-SPM-004, *Sample Storage & Handling Procedures for Mitigation of Sample and Laboratory Contamination,* current revision

15.11 TestAmerica Edison Work Instruction No. EDS-WI-041, *8260B ICAL Procedure*, current revision.

15.12 TestAmerica Edison SOP No. ED-GCV-001, *Screening for Volatile Organics, Static Headspace with GC FID, SW846 Method 5021*, current revision

15.13 TestAmerica Edison SOP No. ED-GEN-022, *Training*, current revision.

15.14 TestAmerica Edison SOP No. ED-SPM-008, *Laboratory Waste Disposal Practices*, current revision

16.0 Method Modifications:

N/A

17.0 Attachments

N/A

18.0 Revision History

- Revision 12, dated 09/16/2011:
  - Tables 1 and 7: added cyclopentene, 2-chloro-1,3-butadiene, methacrylonitrile, propionitrile, ethyl methacrylate, 2-nitropropane, indan and isobutyl alcohol to list of target compounds and list of standards sources.
  - Section 7.2.1 and Table 2: Table in Section 7.2.1 and Table 2 updated to include complete list of standards currently in use as well as to update vendor catalog number for several items.
  - Table 3: Initial Calibration Standards Preparation: is now split into three tables to include aqueous low level analysis.
  - Table 5: added following footnote:
    Levels 1 and 2 respectively are prepared in 500ml and 100ml final volumes
    [1]This level is also used as the Continuing Calibration Verification.

- Revision 11, dated 10/27/10:
  - Table 1: added Dichlorofluromethane and 2-ethyl-1-hexanol to list of target analytes.
  - Section 3.1: updated location of Definitions (now in Appendix 2 of LQM).
  - Secton 7.2: 1,4-Dioxane analyte removed from mix 3 and added to AC/AC mix. Lower concentration levels of 1,4-Dioxane and spiking levels changed or added to all corresponding tables throughout document. Tables revised: Section 7.2.1, Section 9.1.2.1.1, Section 9.1.2.1.2, Section 9.1.2.1.3, Section 9.1.2.1.4, and Section 9.1.3.2. Also Table 2, Table 3, Table 3a, Table 4, Table 4a and Table 5.
  - Section 9.1.4: Correction made to number of surrogates added to all QC and samples from 6 to 3
  - Table 7: added characteristic ion information for several compounds that had been missing.

- Revision 10, dated 07/30/10:
  - Tables 1 and 7: added the complete current list of analytes.

- Revision 9, dated 06/04/10:
  - Added section 1.1.2 to include provision for SIM analysis of noted compounds.

- Added Section 2.5: includes text detailing when SIM analysis for select compounds may be necessary.
- Section 3.0: Revised the reference detailing the location of Definitions (was Appendix 5 of Lab Quality Manual, now Appendix 2).
- Section 6.1: Updated instrumentation list.
- Section 7.2: Updated standards names and catalog numbers.
- Section 7.2.1: Footnotes added to select standards in table: "The separate source for this material is not available as a distinct catalog number. Analyst must ensure that a separate lot of the material is selected and used as required."
- Added section 7.2.5 to include SIM internal standard and surrogate standard preparation.
- Revised 9.1.2.1 to change spiking levels to 20ppb from 50ppb as applicable. Acrolein/Acrylonitrile spike levels reflects NJGW limits. Standards names changed as well.
- Sections 9.1.2.2 and 9.1.2.3 deleted. All compounds in the ICV are now evaluated as LCS compounds. Section numbers adjusted accordingly.
- Added Section 9.2.2.2 to include SIM initial calibration preparation. Section numbers adjusted accordingly.
- Added Section 10.1.1.2: SIM Operating Conditions
- Throughout document and Section 15, References: removed all references to Work Instructions containing QC acceptance limits, MDLs and RL and replaced with "For limits, reference the current TALS (LIMS) active Method Limit Group database."
- Throughout document: added standards prep information for propenes (1-Propene, 2-Chloropropane, and 1-Chloropropane)
- Table 2: Renamed 'Working Standards Preparation'. Updated standard names, concentrations and volumes.
- Table 3: Initial Calibration Standards Preparation: is now split into two tables: Table 3: Low Level Soil ICAL Prep and Table 3a: Water Initial Calibration Standards Preparation. The 100 ppb calibration level has been replaced with a 500 ppb calibration level.
- Table 4: split into 2 tables: Table 4 is 'ICV Standards Prep, Low Level Soil' and Table 4 a is 'ICV Standard Preparation, Aqueous'. ICV prep revised to reflect lower concentrations.
- Table 5: SIM Initial Calibration Standards Preparation added.
- Table 6: SIM ICV/LCS/MS/MSD Standard Preparation added.

- Revision 8, dated 10/23/08:
  - Revised SOP format in accordance with TestAmerica Corporate Quality SOP No. CW-QS-002 (Rev 0) Writing a Standard Operating Procedure (SOP).
  - Section 1.1: Updated list of Method Analytes (Table 1)
  - Section 1.1.3: Added reference to TestAmerica Edison Work Instruction No. EDS-WI-076, *SW846 Method 8260B: Current MDLs and Reporting Limits*, current revision.
  - Section 1.1.4: Added reference to Quality Assurance Manual for method Modifications
  - Section 2: Expanded to include references to applicable prep and screening SOPs.
  - Section 3: revised to reference new location for definitions.

- Section 5: Revised to include most up to date corporate health and safety references and information.
- Section 6: Updated with current instrumentation and configurations. Replaced helium purge gas with nitrogen purge gas (throughout SOP).
- Section 7.1: added details of the solvent testing and approval program.
- Section 7.2: Updated standards sources and catalog numbers. Added tables detailing components found in the various standards mixes. Added details on ICV prep.
- Section 7: The new initial calibration range is 1ppb to 200ppb for most compounds and 10ppb -200ppb for ketones.
- Section 8: Updated with additional details including a table outlining containers, preservation and holding times for waters and soils.
- Section 9.1: Expanded QC sample preparation, analysis, evaluation and corrective action details.
- Section 9.2: Expanded details of preparation, analysis, evaluation and corrective action for instrument performance check, initial and continuing calibration and calibration verifications. Added a table summarizing Instrument QC Requirements. Added reference to TestAmerica Edison Work Instruction, EDS-WI-023, *Current Method 8260B Surrogate and QC Limits,* current revision.
- Section 10: Revised and expanded to include instrument operating conditions, sample prep details, reference to the screening procedure, standard and sample analytical sequence, data processing, data interpretation and qualitative identification (target and non-target compounds).
- Section 11: Deleted reference to SOP for Organic Calculations. Added all applicable calculations.
- Section12.0: added reference to Training SOP.
- References: Expanded to include more specific SOP references.
- Tables: updated to reflect changes in standards sources and concentrations. Added ICV Prep info in Table 4.
- Revision history: updated.

- Revision 7, effective date 8/21/07:
  - Revised section 9.3.3 to include six calibration standards in place of five.
  - Revised Table 4 in section 9.3.3 to include the additional calibration standard prepared at 10ppb.
  - Deleted section 9.4.8.2.1 which read "*if a second order regression calibration is to be used, an additional (6th) point in the calibration must be analyzed.*" The laboratory always runs a six point calibration for this method.

Table 2: Working Standards Preparation							
Target Compound Standard Name	**Lab Name**	**Vendor**	**Cat. #**	**Vol. Std. Added**	**Conc. of Stock Std.**	**Concentration of Standard**	**Final Vol/ Total vol of MeOH**
Gas Mix	Gas (Hi)	Supelco	48799U	7.50 mL	2000ppm	500ppm	30mL 22.5mL TV/M
Gas Mix	Gas (Li)	Supelco	48799U	500 uL	2000ppm	50ppm	20mL 19.5mL TV/M
8260 Mix 1*	Mix 1 (Hi)	Supelco	5-02111	10.0 ml	2000ppm	500ppm	40mL 30mL TV/M
8260 Mix 1*	Mix 1 (Li)	Supelco	5-02111	1.0 ml	2000ppm	50ppm	40ml 39ml TV/M
Ketone Mix		Absolute	82402	500 ul	2000ppm	50ppm	20ml 19.5ml TV/M
8260 Mix 5* 8260 Mix 6 * 2-Chlorethylvinylether Extra compound mix *	Mix 2 (Hi)	Supelco Supelco	86-1323 86-1309 86-1206 21391813	10ml 10ml 10ml 1ml	2000ppm 20000ppm	500ppm	40mL 9.0mL TV/M
8260 Mix 5* 8260 Mix 6* 2-Chlorethylvinylether* Extra compound mix *	Mix 2 (Li)	Supelco Supelco	86-1323 86-1309 86-1206 21391813	1ml 1ml 1ml 100ul	2000ppm 20000ppm	50ppm	40mL 36.9mL TV/M
Alcohols*	MIX 3	SPEX	VO-TANJ-4	4ml	50000ppm (varied)	5000ppm (varied)	40mL 36mL TV/M
Acrolein/Acrylonitrile/ Dioxane*	AC/AC/ 1,4-Dioxane	SPEX	VO-TANJ-3	4ml	20000ppm	500/250 250ppm	40ml 36ml TV/M
Propenes*	Propenes	Supelco	21240202	NA	1000/2000 ppm	NA	NA
Propenes*	Propenes	Supelco	21240202	1ml	1000/2000 ppm	50ppm (varied)	20ml/ 19ml
Isobutyl Alcohol	IBA	Absolute	70445	NA	1000ppm	NA	NA
Methacrylonitrile, 2-Chloro-1,3-butadiene, Ethly methacrylate, Propionitrile, Cylcopentene, 2-Nitropropane Indan	NA	Absolute	70442 70483 70381 70349 70519 70461 70955	NA	1000ppm	NA	NA

Table 2: Working Standards Preparation

Target Compound Standard Name	Lab Name	Vendor	Cat. #	Vol. Std. Added	Conc. of Stock Std.	Concentration of Standard	Final Vol/ Total vol of MeOH
8260 Mix 1 (2nd source)* 8260 Mix 5 (2nd source) * 8260 Mix 6 (2nd source) * Extra Compound mix (2nd source)*	8260 SP	Supelco SPEX	5S02111 8S61323 8S61309 VO-TANJ-8	1ml 1ml 1ml 1ml	2000ppm 2000ppm	50ppm	40ml 36.0mL TV/M
Alcohols (2nd source)*	MIX 3 SP	SPEX	XQ-4168	4ml	50000ppm (varied)	5000ppm (varied)	40mL 36mL TV/M
Gas Mix 2-Chlorethylvinylether (2nd source)*	GAS SP	Supelco	4S8799U 8S61206	1ml 1ml	2000ppm	50ppm	40mL 38mL TV/M
Acrolein/Acrylonitrile/Dioxane (2nd source)*	AC/AC SP	SPEX	XQ-3840	4ml	20000ppm	500/250/ 250ppm	40ml 36.0TV/M
8260 Mix 1* (SIM)	SIM MIX1	Supelco	5-02111	50ul	2000ppm	10ppm	10ml 9.95 TV/M
Propenes* (2nd source)	Propene SP	SPEX	XQ-4113 XQ-4114	1ml	1000/2000ppm	50ppm (varied)	20ml/ 19ml
1,4-Dioxane	1,4-Dioxane	Supelco	360481	483.6 ul	Neat	50000ppm	10ml/9.52 TVM
1,4-Dioxane	1,4-Dioxane	Supelco	NA	100ul	50000ppm	500ppm	10ml/9.90 TVM
1,4-Dioxane (2nd source)	1,4-Dioxane	Absolute	93501	1ml	5000ppm	500ppm	10ml/9ml TV/M
Isobutyl Alcohol (SS)	IBA	Absolute	70445	NA	1000ppm	NA	NA
Methacrylonitrile,(SS) 2-Chloro-1,3-butadiene (SS) Ethly methacrylate (SS) Propionitrile (SS) Cylcopentene (SS) 2-Nitropropane (SS) Indan (SS)	NA	Absolute	70442 70483 70381 70349 70519 70461 70955	NA	1000ppm	NA	NA

Asterisk (*) indicates a custom standard mix.

Table 3: Initial Calibration Standards Preparation, Low Level Soil

Standard Solution	Final Volume Reagent Water (ml)	Volume of Standard Added to Reagent Water (ul)					
		1ppb *	5ppb*	20ppb	50ppb[1]	200ppb	500ppb
Gas Mix (50ppm)	5	0.1	0.5	2.0	5	-	-
	50	1.0	5.0	20.0	50	-	-
Gas Mix (500ppm)	5	-	-	-		2.0	5.0
	50	-	-	-		20.0	50.0
Mix 1 (Li) (50ppm)	5	0.1	0.5	2.0	5	-	-
	50	1.0	5.0	20.0	50	-	-
Mix 1 (Hi) (500ppm)	5	-	-	-	-	2.0	5.0
	50	-	-	-	-	20.0	50.0
Ketone Mix (50 ppm)	5	0.9	1	-	-	-	50.0
	50	9.0	10.0	-	-	-	500.0
Mix 2 (Li) (50ppm)	5	0.1	0.5	2.0	5	-	-
	50	1.0	5.0	2.0	50	-	-
Mix 2 (Hi) (500ppm)	5	-	-	-	-	2.0	5.0
	50	-	-	-	-	20.0	50.0
Mix 3 (varied)	5	1.0	2.0	3.0	4.0	5.0	6.0
	50	10.0	20.0	30.0	40.0	50.0	60.0
AC/AC/1,4-Dioxane (500/250/250ppm)	5	1.0	2.0	3.0	4.0	5	6.0
	50	10.0	20.0	30.0	40.0	50.0	60.0
Propenes	5	0.1	0.5	2.0	5.0	20	50
	50	1.0	5.0	20.0	50	200	500

*Ketones are at 10ppb and 15ppb in levels 1 and 5 respectively
[1]**This level is also used as the Continuing Calibration Verification.**

Table 3a: Initial Calibration Standards Preparation, Aqueous

Standard Solution	Volume of Standard Added to Reagent Water (ul)					
	1ppb*	5ppb*	20ppb[1]	50ppb	200ppb	500ppb
Gas Mix (500ppm)	1	1	2	5	20	50
Mix 1 (Hi) (500ppm)	1	1	2	5	20	50
Mix 2 (Hi) (500ppm)	1	1	2	5	20	50
Mix 3 (varied)	100	40	30	40	50	60
AC/AC/1,4-Dioxane (500/250/250ppm)	4	4	4	10	20	40
1,4-Dioxane (500ppm)	48	18	13	15	15	10

Standard Solution	Volume of Standard Added to Reagent Water (ul)					
	1ppb*	5ppb*	20ppb[1]	50ppb	200ppb	500ppb
Ketones	90	20	NA	NA	NA	NA
Propenes (1000/2000ppm)	0.5	0.5	1	2.5	10	25
Methanol Compensate	2303	433	210	185	120	0
Final vol. (reagent water)	**500 ml**	**100ml**	50 ml	50ml	50ml	50ml

*Ketones are at 10ppb and 15ppb in levels 1 and 5 respectively and are prepared in 500ml and 100ml final volumes

[1]This level is also used as the Continuing Calibration Verification.

Table 3b: Initial Calibration Standards Preparation, Aqueous (LOW LEVEL)

Standard Solution	Volume of Standard Added to Reagent Water (ul)					
	0.5ppb*	1ppb*	20ppb[1]	50ppb	200ppb	500ppb
Gas Mix (500ppm)	0.5	1	2	5	20	50
Mix 1 (Hi) (500ppm)	0.5	1	2	5	20	50
Mix 2 (Hi) (500ppm)	0.5	1	2	5	20	50
Mix 3 (varied)	5.0	100	30	40	50	60
AC/AC/1,4-Dioxane (500/250/250ppm)	2	4	4	10	20	40
1,4-Dioxane (500ppm)	24	48	13	15	15	10
Ketones	45	90	NA	NA	NA	NA
Propenes (1000/2000ppm)	0.25	0.5	1	2.5	10	25
Methanol Compensate	2303	433	210	185	120	0
Final vol. (reagent water)	**500 ml**	**500ml**	50 ml	50ml	50ml	50ml

*Ketones are at 10ppb and 15ppb in levels 1 and 5 respectively and are prepared in 500ml and 100ml final volumes

[1]This level is also used as the Continuing Calibration Verification.

Table 4 : ICV Standard Preparation, Low Level Soil

Standard Solution	Concentration	Volume of Standard Added to 5.0 ml of Reagent Water (ul)	Final Concentration (ug/L)
8260 SP (LCS) (Separate lot)	50ppm	2	20
MIX 3 (LCS) (Separate lot)	5000ppm (varied)	3	3000
AC/AC/1,4-Dioxane	500/250/250ppm	3	300/150/150
Gas SP 2-Chlorethylvinylether (LCS) (Separate lot)	50ppm	2	20
Propenes (second source)	50ppm (varied)	2	20 (varied)

Table 4a: ICV Standard Preparation, Aqueous

Standard Solution	Concentration	Volume of Standard Added to 50 ml of Reagent Water (ul)	Final Concentration (ug/L)
8260 SP (LCS) (Separate lot)	50ppm	20	20
MIX 3 (LCS) (Separate lot)	5000ppm (varied)	30	3000
AC/AC/1,4-dioxane SP	500/250/250ppm	4	40/20/20
Gas SP 2-Chlorethylvinylether (LCS) (Separate lot)	50ppm	20	20
1,4-Dioxane SP	500ppm	13	130
Propenes (second source)	50ppm (varied)	20	20 (varied)

Table 5: SIM Initial Calibration Standards Preparation

Standard Solution	Volume of Standard Added to Reagent Water (ul)					
	2 0.02ppb	**5 0.05ppb**	**10 0.1ppb**	**20[1] 0.50ppb**	**30 1ppb**	**40 2ppb**
Mix 1 (SIM) (10ppm)	1	0.5	0.5	2.5	5	10
1,4-Dioxane @ 500ppm	2	1	1	2	3	4
8260IS/SS @ 25ppm	10	2	1	1	1	1
Final Volume (reagent water)	**500ml**	**100ml**	**50ml**	**50ml**	**50ml**	**50ml**

Levels 1 and 2 respectively are prepared in 500ml and 100ml final volumes
[1]**This level is also used as the Continuing Calibration Verification.**

Table 6 : SIM ICV/LCS/MS/MSD Standard Preparation

Standard Solution	Concentration	Volume of Standard Added to 50 ml of Reagent Water (ul)	Final Concentration (ug/L)
8260 SP (Second source)	50ppm	0.5	0.50
1,4-Dioxane SP	500ppm (varied)	2	20
8260 IS/SS	25ppm	1	0.5

TABLE 7
Characteristic Ions of Volatile Organic Compounds

Parameter	Primary ion	Secondary ion
1,1,1-Trichloroethane	97	99,117,119
1,1,2,2-Tetrachloroethane	83	85,131,133,166
1,1,2-Trichloroethane	97	83,85,99,132,134
1,1-Dichloroethane	63	65,83,85,98,100
1,1-Dichloroethene	96	61,98
1,1-Dichloropropene	75	110. 77
1,2,3-Trichlorobenzene	180	182
1,2,3-Trichloropropane	110	75
1,2,4-Trichlorobenzene	180	182, 145
1,2,4-Trimethylbenzene	105	120
1,2-Dibromo-3-Chloropropane	75	155, 157
1,2-Dibromomethane	107	109
1,2-Dichloroethane	62	64,100,98
1,2-Dichloroethene	96	61,98
1,2-Dichloropropane	63	65,114
1,2-Dichlorotrifluoroethene	67	117
1,2-Difluorotetrachloroethene	101	103, 167
1,3,5-Trimethylbenzene	105	120
1,3-Dichlorobenzene	146	148, 111
1,4-Dichlorobenzene	146	148, 111
1,4-Dioxane	88	58
1-Chloropropane	63	78
1-Propene	41	42
2,2-Dichloropropane	77	97
2,4,4-trimethyl-1-pentene	41	57, 97
2-Butanone	72	57
2-Chloroethyl vinyl ether	63	65, 106
2-Chloropropane	78	63
2-Chlorotoluene	91	126
2-Chloro-1,3-butadiene	88	53
2-Hexanone	43	58,100
2-Nitropropane	39	42, 44
2-Octane	43	58
2-Octanol	45	55
4-Chlorotoluene	91	126
4-Methyl-2-Pentanone	43	58,100
Methacrylonitrile	67	41
Acetone	43	58
Acetonitrile	39	40, 41

TABLE 7
Characteristic Ions of Volatile Organic Compounds

Acrolein	56	55
Acrylonitrile	53	52
Allyl Alcohol	57	40, 39
Allyl Chloride	76	41
Amyl Acetate	43	70, 61
Benzene	78	--
Benzyl Chloride	91	126, 65
Bromobenzene	156	77, 158
Bromochloromethane	129	49, 130
Bromodichloromethane	83	85
Bromoform	173	171,175,
Bromomethane	94	96
Butyl Acetate	73	56, 43
Butyl Acrylate	73	56, 55
Butyl methacrylate	87	69
Camphene	93	121
Camphor	95	81
Carbon disulfide	76	78
Carbon tetrachloride	117	119,121
Chlorobenzene	112	114
Chloroethane	64	66
Chloroform	83	85
Chloromethane	50	52
Chlortrifluoroethene	116	118
cis-1,3-Dichloropropene	75	77
Cyclohexane	56	84, 69
Cyclopentene	67	68, 68, 53
Dibromochloromethane	129	208,206
Dibromomethane	93	95, 174
Dichlorodifluoromethane	85	87
Dimethylnaphthalene (total)	141	156, 155
Epichlorohydrin	57	62, 49
Ethanol	46	45
Ethyl Acetate	70	61, 43
Ethyl Acrylate	55	56
Ethyl Ether	59	74, 75
Ethylbenzene	106	91,
Ethyl methacrylate	69	41, 99
Freon TF	101	103, 151, 85
Hexachlorobutadiene	225	223
Hexane	56	57, 86
Indan	117	118, 58

TABLE 7
Characteristic Ions of Volatile Organic Compounds

Iodomethane (methyl iodide)	142	127
Isobutyl Alcohol (Isobutanol)	43	41, 42
Isoprene	67	53, 59
Isopropanol	45	59
Isopropyl Acetate	43	61, 87
Isopropyl Ether (DIPE)	45	87
Isopropylbenzene	105	120
Methyl Acetate	43	74
Methyl cyclohexane	83	55, 98
Methyl Methacrylate	100	69
Methyl tert-butyl ether (MTBE)	73	57
Methylene chloride	84	49,51,86
Methylnaphthalene (total)	142	141, 115
Naphthalene	12	--
n-Butanol	56	41, 43
n-Butylbenzene	91	92, 134
n-Heptane	57	43, 71
n-Pentane	72	57
N-Propanol	60	59
n-Propylbenzene	91	120
P-Isopropyltoluene`	119	134, 91
Propyl Acetate	43	61, 73
Propionitrile	54	52, 54
sec-Butylbenzene	105	134
Styrene	104	78,103
Tert-Amyl Methyl Ether	73	55, 87
Tert-butyl Alcohol	59	--
Tert-Butyl Ethyl Ether	59	87
Tert-Butylbenzene	119	91, 134
Tetrachloroethene	164	129,131,166
Tetrahydrofuran	42	72, 71
Toluene	92	91
Total Xylenes	106	91
trans,-1,3-Dichloropropene	75	77
Trans-1,4-dichloro-2-butene	53	75
Trichloroethene	130	95,97,132
Trichlororfluoromethane	101	103
Vinyl acetate	43	86
Dichlorofluoromethane	67	69
Chlorotrifluoroethene	116	118
1,2-tetrachlorodifluoroethane	101	103,167
1,2-Dichlorotrifluoroethane	67	117

TABLE 7
Characteristic Ions of Volatile Organic Compounds

Vinyl chloride	62	64
4-Bromofluorobenzene (sur)	95	174,176
1,2-Dichloroethane-d4 (sur)	65	102, 104
Toluene-d8 (sur)	98	70,100
Fluorobenzene (istd)	96	77
Chlorobenzene-d5 (istd)	117	82,119
1,4-Dichlorobenzene-d4 (istd)	152	115,150

Title: SW846 Method 8260C, Volatile Organic Compounds by Gas Chromatography/Mass Spectrometry (GC/MS)

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Approvals (Signature/Date):

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1.0 Scope and Application

1.1 Analytes, Matrix(s), and Reporting Limits

1.1.1 USEPA SW846 Method 8260C is used for the determination of volatile organic compounds in a variety of aqueous and solid matrices by purge and trap gas chromatography (GC)/mass spectrometery (MS). The method is applicable to the compounds listed in Table 1 (below). Actual target compound lists are determined through regulatory or project specifications. Method performance criteria for each target analyte will be determined prior to sample analysis.

1.1.2 This SOP also describes the optional procedure for analyses of compounds using Selected Ion Monitoring (SIM). SIM analyses is specific to target compounds: 1,2-dibromoethane, 1,2-dibromo-3-chloropropane and 1,4-Dioxane.

Table 1: Method Analytes

COMPOUND	CAS#	COMPOUND	CAS#
Acetone	67-64-1	Epichlorohydrin	106-89-8
Acetonitrile	75-05-8	Ethylbenzene	100-41-4
Acrolein (Propenal)	107-02-8	Ethyl methacrylate	97-63-2
Acrylonitrile	107-13-1	Fluorobenzene (IS)	462-06-6
Allyl alcohol	107-18-6	Hexachlorobutadiene	87-68-3
Benzene	71-43-2	2-Hexanone	591-78-6
Benzyl chloride	100-44-7	Iodomethane	74-88-4
Bromochloromethane	74-97-5	Isobutyl alcohol	78-83-1
Bromodichloromethane	75-27-4	Isopropylbenzene	98-82-8
4-Bromofluorobenzene (surr)	460-00-4	Ethyl Ether	60-29-7
Bromoform	75-25-2	Freon 113	76-13-1
Bromomethane	74-83-9	Methylene chloride	75-09-2
n-Butanol	71-36-3	Methyl methacrylate	80-62-6
2-Butanone (MEK)	78-93-3	4-Methyl-2-pentanone (MIBK)	108-10-1
t-Butyl alcohol	75-65-0	Naphthalene	91-20-3
Butyl Acrylate	141-32-2	Isoprene	78-79-5
Butyl Methacrylate	97-88-1	n-Butyl Acetate	123-86-4
Camphene	79-92-5	n-Propyl Acetate	109-60-4
Camphor	76-22-2	2-Octanol	4128-31-8
Carbon disulfide	75-15-0	1-Propanol	71-23-8
Carbon tetrachloride	56-23-5	2-Propanol(Isopropanol)	67-63-0
Chlorobenzene	108-90-7	n-Heptane	142-82-5
Chlorobenzene-d5 (IS)	3114-55-4	n-Hexane	110-54-3
Chlorodibromomethane	124-48-1	tert-Amyl methyl ether	994-05-8
Chloroethane	75-00-3	tert-Butyl ethyl ether	637-92-3
2-Chloroethyl vinyl ether	110-75-8	Styrene	100-42-5
Chloroform	67-66-3	1,1,1,2-Tetrachloroethane	630-20-6

COMPOUND	CAS#	COMPOUND	CAS#
Chloromethane	74-87-3	1,1,2,2-Tetrachloroethane	79-34-5
Dibromomethane	74-95-3	Tetrachloroethene	127-18-4
1,2-Dichlorobenzene	95-50-1	Toluene	108-88-3
1,3-Dichlorobenzene	541-73-1	Toluene-d8 (surr)	2037-26-5
1,4-Dichlorobenzene	106-46-7	Pentyl Acetate(Amyl Acetate)	628-63-7
1,4-Dichlorobenzene-d4 (IS)	3855-82-1	1,2,4-Trichlorobenzene	120-82-1
trans-1,4-Dichloro-2-butene	110-57-6	1,1,1 -Trichloroethane	71-55-6
Dichlorodifluoromethane	75-71-8	1,1,2-Trichloroethane	79-00-5
1,1-Dichloroethane	75-34-3	Trichloroethene	79-01-6
1,2-Dichloroethane	107-06-2	Trichlorofluoromethane	75-69-4
1,2-Dichloroethane-d4 (surr)	17060-07-0	1,2,3-Trichloropropane	96-18-4
1,1-Dichloroethene	75-35-4	Vinyl acetate	108-05-4
trans-1,2-Dichloroethene	156-60-5	Vinyl chloride	75-01-4
1,2-Dichloropropane	78-87-5	o-Xylene	95-47-6
cis-1,3-Dichloropropene	10061-01-5	m-Xylene	108-38-3
1,3-Dimethylnaphthalene	575-41-7	p-Xylene	106-42-3
Diethyl ether	60-29-7	Bromobenzene	108-86-1
1,4-Dioxane	123-91-1	n-Butylbenzene	104-51-8
Methyl acrylate	96-33-3	sec-Butylbenzene	135-98-8
Methyl-t-butyl ether	163-404-4	tert-Butylbenzene	98-06-6
Methyl Acetate	79-20-9	Methyl Cyclohexane	108-87-2
n-Propylbenzene	103-65-1	2-Octanone	111-13-7
1,2,3-Trichlorobenzene	87-61-6	4-Chlorotoluene	106-43-4
1,2,4-Trimethylbenzene	95-63-6	cis-1,2-Dichloroethene	156-59-2
1,3,5-Trimethylbenzene	108-67-8	1,3-Dichloropropane	142-28-9
Tetrahydrofuran	109-99-9	2,2-Dichloropropane	590-20-7
2-Methylnaphthalene	91-57-6	p-Isopropyltoluene	99-87-6
1,1,2-Trichloro-1,2,2-Trifluoroethane	76-13-1	Ethyl Acetate	141-78-6
		trans-1,3-Dichloropropene	10061-02-6
1-Propene	115-07-1	Ethanol	64-17-5
2-Chloropropane	75-29-6	Xylenes (total)	133-0207
1-Chloropropane	540-54-5	Isopropyl Ether (DIPE)	108-20-3
Dichlorofluoromethane	75-43-4	2-Ethyl-1-Hexanol	104-76-7
Methacrylonitrile	126-98-7	Propionitrile	107-12-0
2-Chloro-1,3-butadiene (chloroprene)	126-99-8	Ethyl methacrylate	97-63-2
Isobutyl Alcohol	78-83-1	2-Nitropropane	79-46-9
Cyclopentene	142-29-0	Indan	496-11-7

1.1.3 Method 8260C can be used to quantitate most volatile organic compounds that have boiling points below 200°C, and that are insoluble or slightly soluble in water. Water-soluble compounds can be included in this method, but quantitation limits will be higher due to poor purging efficiency.

1.1.4 The standard reporting limit (RL) is established at or above the low-level standard in the calibration curve. For a complete list of method

detection limits (MDLs) and RLs, please see reference the current TALS (LIMS) active Method Limit Group database.

1.1.5 On occasion clients may request modifications to this SOP. These modifications are handled following the procedures outlined in Sections 7 (*Review of Work Request*) and 20 (*Test Methods and Method Validation*) of TestAmerica Edison's Quality Assurance Manual (ED-QA-LQM).

2.0 Summary of Method

2.1 Method 8260C is used to determine volatile organic compounds in aqueous, non-aqueous and solid matrices. Sample preparation techniques vary, depending on the matrix and the level of contamination expected. Purge and trap techniques are used to introduce the sample to the GC/MS system. Refer to TestAmerica Edison SOP Nos. ED-MSV-001, *Purge and Trap for Aqueous Samples, SW846 Method 5030*, current revision and ED-MSV-002, *Closed-System Purge-and-Trap and Extraction for Volatile Organics in Soil and Waste Samples, SW846 Method 5035,* current revision.

2.2 All samples extracts are screened by GC/FID static headspace analysis to provide the analyst with appropriate initial dilution factors. For additional details see TestAmerica Edison SOP No. ED-GCV-001, *Screening for Volatile Organics, Static Headspace with GC FID, SW846 Method 5021*, current revision.

2.3 An aliquot of sample containing internal standard and surrogate spiking solution is purged with nitrogen in a closed sparging vessel. The volatile compounds are transferred from the aqueous phase to the vapor phase. The vapor is swept through a sorbent column where the volatiles are trapped. After purging is complete, the sorbent column is heated and backflushed with helium to desorb the volatiles onto a gas chromatograph column.

2.4 Analytes eluted from the capillary chromatograhy column are introduced into the mass spectrometer via a direct connection. Identification of target analytes is accomplished by comparing their mass spectra with the electron impact spectra of authentic standards. Quantitation is accomplished by comparing the response of a major (quantitation) ion relative to an internal standard using a minimum of a five-point calibration curve.

2.5 For aqueous VOA samples submitted for New Jersey Groundwater Quality Standard (NJ GWQS) evaluation, a full scan analysis is initially performed using the 8260 method. No further analysis by SIM is required if all of the following compounds are present above the full scan RL: 1,2-dibromoethane, 1,2-dibromo-3-chloropropane and 1,4-dioxane. If any of these compounds are undetected in the undiluted, full scan analysis, the sample must be analyzed via 8260C SIM for those compounds.

2.6 To meet lower reporting limits of 0.5ug/L for most analytes, 5ug/L for ketones and generally lower limits for other non-routine analytical compounds, spike at the appropriate levels using existing purging conditions. The corresponding TALS

login method for low level aqueous analysis is 8260_LL. See Table 3b for initial calibration levels and spike amounts.

3.0 Definitions

3.1 For a complete list of definitions refer to Appendix 2 in the most current revision of TestAmerica Edison's Quality Assurance Manual (ED-QA-LQM).

4.0 Interferences

4.1 This method is susceptible to contamination from a number of sources, including organic solvents used in other laboratory procedures, impurities in the purge gas, improper cleaning of syringes or purge vessels, and carryover from high level samples. Samples can be contaminated by the diffusion of volatile organics through the septum during shipment or storage. Steps have been taken to ensure that these potential problems are eliminated from the laboratory.

4.2 The volatiles analytical laboratory is housed in a separate building, away from the organic extraction lab area where large quantities of organic solvents are used. No organic solvents are used or stored in the volatiles laboratory.

4.3 The nitrogen used as purge gas passes through a solvent trap prior to its inlet into the purge and trap units.

4.4 A trip blank prepared from organic-free reagent water is carried through the sampling, storage and analysis of each group of samples to check for such contamination.

4.5 Individual samples are each handled with a unique syringe that has been baked in a drying oven at 105°C to ensure the absence of volatile compounds.

4.6 Carryover can occur anytime a high level sample is analyzed. Screening procedures are employed to ensure that a sample is analyzed at an appropriate dilution to minimize potential carryover. When a high level sample is analyzed, it is followed by the analysis of a reagent water blank. If another sample was analyzed after the high level sample, this sample is inspected carefully for signs of carryover. If this sample does not contain any of the compounds found in the high level sample, the system can be considered contamination free.

4.7 The analytical system is checked daily with the analysis of a method blank. This blank must meet all quality control criteria for the method before sample analysis may take place.

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.

Any questions pertaining to safety issues or procedures should be brought to the department manager or Edison Safety Officer.

5.1 Specific Safety Concerns or Requirements

5.1.1 Latex, nitrile and vinyl gloves all provide adequate protection against the methanol used in this method.

5.1.2 Purge vessels on purge-and-trap instruments can be pressurized by the time analysis is completed. Vent the pressure prior to removal of these vessels to prevent the contents from spraying out.

5.1.3 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.

5.1.4 The mass spectrometer is under deep vacuum. The mass spectrometer must be brought to atmospheric pressure prior to working on the source.

5.1.5 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.

5.2 Primary Materials Used

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
Methanol (MeOH)	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.			

6.0 Equipment and Supplies

6.1 Instrumentation

6.1.1 Purge and trap units from several different manufacturers are used, depending upon the sample matrix and preparatory technique required. A purge and trap unit consists of three parts: the sample purge unit, the trap, and the concentrator. Unit configurations currently in use are:

- OI Analytical 4551 Automatic Sampler/4560 concentrator;
- Archon 5100A Automatic sampler/ OI Analytical 4660 concentrator;
- EST Centurion Autosampler/ EST Encon concentrator;
- Archon Autosampler/EST Encon concentrator.
- Archon/EST Evolution

6.1.2 A VOCARB 3000 trap from Supelco is used in the Encon concentrator. The trap is 25cm long with an inside diameter of 0.105 inches. The trap is packed with 10.0cm Carbopack B, 6.0 cm Carboxin 1000, and 1cm Carboxin 1001.

6.1.3 An OI analytical purge trap #10 is used for the OI 4560 concentrator. The trap is 25cm long with an inside diameter of 0.105 inches. The trap is packed to contain the following absorbents: Tenax/silica gel/carbon molecular sieve.

6.1.4 Alternate traps may be used provided the adsorption and desorption characteristics are equivalent to those of the trap recommended by the method.

6.1.5 Both the Encon and OI concentrators are capable of rapidly heating the trap to 260°C and holding at that temperature for the duration of the desorb time.

6.1.6 Gas chromatograph: HP 5890/Agilent 6890/7890 equipped with temperature programming capability.

6.1.7 GC column: 75M long x 0.53mm ID, J&W DB-624 capillary column with 3um film thickness, 20M x 0.18mm x 1um DB-624 and 20M long x 0.18 mm ID Restek Rtx-VMS capillary column with 1um film thickness or similar phase.

6.1.8 Mass Spectrometer (5971/5972/Agilent 5973/5975): scanning from 35-260 amu every 0.9 seconds, utilizing 70 volts (nominal) electron energy in the electron ionization mode and producing a mass spectrum which meets all EPA performance criteria when 50 ng of 4-

Bromofluorobenzene (BFB) is injected through the gas chromatograph inlet.

6.1.9 GC/MS Interface: glass jet separator with fused silica transfer lines heated to 180°C or capillary direct.

6.1.10 Data system: HP Chemstation II for data acquisition and HP UNIX based TARGET software for data processing.

6.2 Supplies

- Microsyringes: 10 ul to 1000 ul.
- Syringes: 5 ml to 25 ml gas-tight.
- Injection port liners: HP 18740-80200 or equivalent
- Volumetric flasks: Class "A" glassware, 5 ml to 500 ml.
- VOA vials: 20-ml and 40-ml glass with PTFE – faced septum.
- Vials: 2-ml amber glass with screw cap with Teflon-faced septa.
- Top loading analytical balance.
- Spatula: Narrow, stainless steel.
- Stir bars: PTFE coated, small enough to spin freely inside a VOA vial.

7.0 Reagents and Standards

7.1 Reagents

7.1.1 Organic free reagent water: Distilled water purchased from Poland Spring or equivalent.

7.1.2 Methanol: Ultra Resi-Analyzed, purge and trap grade, purchased from JT Baker or equivalent. (Cat # 9077-02)

7.1.2.1 Each lot of methanol is screened for contaminants before being used for analysis as detailed in TestAmerica Corporate Quality SOP No. CA-Q-S-001 (*Solvent & Acid Lot Testing & Approval*) and TestAmerica Edison SOP No. ED-GEN-023 (*Bulk Solvent Testing and Approval*).

7.2 Standards

7.2.1 **Calibration Standards** Stock target compound analytical standard solutions are purchased mainly from Supelco, Inc, Absolute

Standards and Spex although standards of similar quality from other suppliers may be substituted as required. Standards noted with an asterisk (*) are custom mixes made especially for TestAmerica Edison.

Target Analyte Standard Name	Concentration	Vendor	Catalog #
Gas Mix	2000 ppm	Supelco	48799U
Gas Mix (Second source)	2000 ppm	Supelco	4S8799U
8260 Mix 1 *	2000 ppm	Supelco	5-02111
8260 Mix 1 (Second source)*	2000 ppm	Supelco	5S02111
8260C Mix 5 *	2000 ppm	Supelco	86-1323
8260C Mix 5 (Second source) *	2000 ppm	Supelco	8S61323
8260C Mix 6 *	2000 ppm	Supelco	86-1309
8260C Mix 6 (Second source) *	2000 ppm	Supelco	8S61309
Alcohols *	50000 ppm (varied)	SPEX	VO-TANJ-4
Alcohols (Second source) *	50000 ppm (varied)	SPEX	VO-TANJ-4
2-Chlorethylvinylether *	2000 ppm	Supelco	86-1206
2-Chlorethylvinylether (Second source) *	2000 ppm	Supelco	8S61206
Ketone Mix	2000 ppm	Absolute	82402
Ketone Mix (note:in second source of 8260C mix 5) *	2000 ppm	Supelco	8S61323
Extra compound Mix *	20000ppm	Supelco	21240200
Extra Compound Mix (Second source) *	20000 ppm	SPEX	XQ-3840
Extra Compound Mix (Second source) *	2000 ppm	SPEX	VO-TANJ-8
Acrolein/Acrylonitrile/Dioxane (AC/AC)*	5000/2500/2500 ppm	SPEX	VO-TANJ-3
Acrolein/Acrylonitrile/Dioxane (AC/AC) * (Second source)	5000/2500/2500 ppm	SPEX	VO-TANJ-3
1,4-Dioxane	1000ppm	Absolute	70373
1,4-Dioxane (second source)	5000ppm	Absolute	93501
1,4-Dioxane	Neat	Sigma	360481
Propenes *	1000/2000ppm	Supelco	21240202
Propenes * (Second source)	1000/2000ppm	SPEX	XQ4113/ XQ4114
Freons*	1000ppm	SPEX	VO-TANJ-6
Cyclopentene	1000ppm	Absolute	70519
Cyclopentene (second source)	1000ppm	Absolute	70519
Indan	1000ppm	Absolute	70955
Indan (second source)	1000ppm	Absolute	70955
2-Nitropropane	1000ppm	Absolute	70461
2-Nitropropane (second source)	1000ppm	Absolute	70461
2-Chloro-1,3-butadiene (chloroprene)	1000ppm	Absolute	70483
2-Chloro-1,3-butadiene (chloroprene) SS	1000ppm	Absolute	70483
Methacrylonitrile	1000ppm	Absolute	70442
Methacrylonitrile (second source)	1000ppm	Absolute	70442
Propionitrile	1000ppm	Absolute	70349
Propionitrile (second source)	1000ppm	Absolute	70349
Ethyl methacrylate	1000ppm	Absolute	70381
Ethyl methacrylate (second source)	1000ppm	Absolute	70381
Isobutyl Alcohol	1000ppm	Absolute	70445

Target Analyte Standard Name	Concentration	Vendor	Catalog #
Isobutyl Alcohol (second source)	1000ppm	Absolute	70445
Cyclopentene	1000ppm	Absolute	70519
Cyclopentene (second source)	1000ppm	Absolute	70519

(1): The separate source for this material is not available as a distinct catalog number. Analyst must ensure that a separate lot of the material is selected and used as required.

An asterisk (*) indicates a custom standard mix.

7.2.1.1. Prepare stock solutions at volumes and concentrations indicated in Table 2 (Working Standards Preparation) by combining the indicated volumes of each stock solution into a volumetric flask corresponding to the total final volume. Dilute to the volume marker with methanol.

7.2.1.2. Prepare individual calibration standards as detailed in Section 9.2.2.1, Table 3, Initial Calibration Standards Preparation, Low Level Soil, and Table 3a, Initial Calibration Standards Preparation, Aqueous.

7.2.1.3. The 'Second Source' standards listed are used in the preparation of both the Initial Calibration Verification (ICV) standard (see Tables 4 and 4a for ICV preparation instructions) and the Laboratory Control Standard (LCS) (see Section 9.1.3 and Tables 4 and 4a).

7.2.2 **Surrogate Standards:** Surrogate standard solutions are prepared from the following individual neat compounds purchased from Sigma Aldrich:

Surrogate Standard Name	Concentration	Vendor	Catalog #
4-Bromofluorobenzene	Neat	Sigma Aldrich	B67201
Toluene-d8	Neat	Sigma Aldrich	151998
1,2-Dichloroethane-d4	Neat	Sigma Aldrich	396540

7.2.2.1 A primary surrogate stock solution (2500 ppm each) is prepared from the neat standards as follows:

Standard Name	Vendor	Catalog #	Volume added	Concentration of Stock Std.	Concentration of Standard	Total Volume Volume of MeOH
8260C 1°Surrogate Mix: 4-Bromofluorobenzene Toluene-d8 1,2-Dichloroethane-d4	Sigma Aldrich	 B67201 151998 396540	 1585 ul 2678 ul 1932 ul	Neat	2500ppm	1000 ml

7.2.2.2 Secondary surrogate standard solutions are prepared at two (2) levels using the 2500 ppm primary stock solution as detailed in the table below:

Standard Name	Vendor	Catalog #	Volume added	Concentration of Stock Std.	Concentration of Standard	Total Volume Volume in MeOH/Total volume of MeOH
8260C Surrogate Mix: 4-Bromofluorobenzene Toluene-d8 1,2-Dichloroethane-d4	Sigma Aldrich	 B67201 151998 396540	4.0mL	2500ppm	500ppm	20mL 16mL TV/M
8260C Surrogate Mix: 4-Bromofluorobenzene Toluene-d8 1,2-Dichloroethane-d4	Sigma Aldrich	 B67201 151998 396540	400uL	2500ppm	50ppm	20mL 19.6mL TV/M

7.2.2.3 Methanol/Surrogate solution (2.5ug/mL): For methanol sampling field kits. Prepared by adding 1mL of 2500 ug/ml primary surrogate stock solution (see Section 7.2.2.1) to 1 L purge and trap grade methanol.

7.2.3 **Internal Standards:** Internal Standards Solutions are purchased from Supelco at two (2) concentration levels:

Standard Name	Concentration	Vendor	Catalog #
8260C Internal Standard Mix: *Chlorobenzene-d5 *1,4-Dichlorobenzene-d4 *Fluorobenzene	2500 ppm each	Supelco	86-1183
8260C Internal Standard Mix: *Chlorobenzene-d5 *1,4-Dichlorobenzene-d4 *Fluorobenzene	250 ppm each	Supelco	86-1184

7.2.4 **Internal Standard/Surrogate Mix (250 ppm each):** A solution containing both Internal Standards and Surrogates at 250 ppm is prepared in a 10ml volumetric flask as detailed below using the 2500 ppm surrogate stock solution prepared in Section 7.2.2.1 and the 2500 ppm internal standard mix detailed in Section 7.2.3:

Standard Name	Concentration of Stock Std.	Volume added to final volume of 10ml MeOH	Final Concentration of Standard
8260C Internal Standard/Surrogate Mix (250 ppm)	2500 ppm Surrogate Mix	1.0ml	250 ppm each component
	2500 Internal Std Mix (Supelco 86-1183)	1.0ml	

7.2.5 **Internal Standard/Surrogate Mix (SIM) (25 ppm each):** A solution containing both Internal Standards and Surrogates at 25 ppm is prepared in a 10ml volumetric flask as detailed below using the 2500 ppm surrogate stock solution prepared in Section 7.2.2.1 and the 2500 ppm internal standard mix detailed in Section 7.2.3:

Standard Name	Concentration of Stock Std.	Volume added to final volume of 10ml MeOH	Final Concentration of Standard
8260C Internal Standard/Surrogate Mix (25 ppm) (SIM)	2500 ppm Surrogate Mix	100ul	25 ppm each component
	2500 Internal Std Mix (Supelco 86-1183)	100ul	

7.2.6 **GC/MS Instrument Performance Check (BFB):** The instrument performance check solution consists of 4-Bromofluorobenzene in addition to the other two surrogates in methanol. Prepare the solution at 50ppm as specified in section 7.2.2.2. Assign an expiration date of 6 months.

7.2.7 All standards preparation information must be logged into the TALS Reagent Module. All pertinent information must be entered: Date prepared, Lot #'s, Expiration dates, Solvents used, Lab Lot # (expiration date), Manufacturer and Verification signature. Additionally, all prepped standards are typically given a unique Lot# and all information pertaining to standard preparation is entered into the GC/MS VOA Standard Preparation Log Book. Information such as standard supplier, lot number, original concentration, a description of how the standard was made, are required along with the laboratory lot number, analyst's initials, date prepared, expiration date and verification signature. Class "A" volumetric must be used at all times and syringes, preferably gas-tight syringes when available, should be checked for accuracy using an analytical balance. Class "A" pipettes should also be used if volumes permit.

7.2.8 Please refer to TestAmerica Edison SOP No. ED-GEN-008, *Standard Operating Procedure for Preparation, Purity and Storage of Reagents and Standards*, current revision. For Method 8260C:

- Shelf Life of Standard: Gas standards are replaced weekly. Non-gas standards must be replaced monthly.
- Storage Requirements: Stock standards are stored at 4°C and working standards stored at -6°C to -20°C.

8.0 Sample Collection, Preservation, Shipment and Storage

Sample container, preservation techniques and holding times may vary and are dependent on sample matrix, method of choice, regulatory compliance, and/or specific contract or client requests. Listed below are the holding times and the references that include preservation requirements.

Matrix	Sample Container	Min. Sample Size	Preservation	Holding Time	Reference
Waters	Glass 40 ml vials	40 mLs	HCl, pH < 2; Cool 4 °C ± 2°C	14 Days / preserved 7 Days / unpreserved	SW846 Method 5030
Soils (Low)	Encore or Terracore (40 ml vials)	5 grams in 5 mls DI H_2O	Frozen Stored -7°C to -20°C	14 Days	SW846 Method 5035
Soils (Med)	Encore or Terracore (40 ml vials)	5 grams in 10 mls MeOH	Cool 4 °C ± 2°C	14 Days	SW846 Method 5030
Soils (High)	Glass (Lab Prepared Kits)	10 grams in 25 mls MeOH	Cool 4 °C ± 2°C	14 Days	SW846 Method 5030

8.1 Storage blanks are prepared by filling 40 mL VOA vials with reagent water and placing one in each refrigerator. After one week, the storage blanks are removed and analyzed. Additional details can be found in TestAmerica Edison SOP No. ED-SPM-004, *Sample Storage & Handling Procedures for Mitigation of Sample and Laboratory Contamination,* current revision.

9.0 Quality Control

9.1 **Sample QC** - The following quality control samples are prepared with each batch of samples:

Quality Controls	Frequency	Control Limit
Method Blank (MB)	1 in 20 or fewer samples	< Rpt. Limit
Laboratory Control Sample (LCS)[1]	1 in 20 or fewer samples	Statistical Limits [4]
Matrix Spike (MS)[2]	1 in 20 or fewer samples	Statistical Limits [4]
MS Duplicate (MSD)[2]	1 in 20 or fewer samples	Statistical Limits [4]
Surrogates	every sample[3]	Statistical Limits [4]
Internal Standards	Every samples	Response within -50% to +100% of CCV

[1] LCS Duplicate (LCD) is performed only when insufficient sample is available for the MS/MSD or when requested by the client/project/contract.
[2] The sample selection for MS/MSD are randomly selected, unless specifically requested by a client….predetermined by the extraction lab.
[3] Analytical and QC samples (MB, LCS, MS/MSD)
[4] Statistical control limits are updated annually and are updated into LIMS.

9.1.1. **Method blanks** are analyzed every 12 hours immediately after successful calibration verification (ICV and CCV) and before any samples are analyzed during the 12 hour clock. Analyze the blank in the same manner as the associated samples.

9.1.1.1. Prepare an aqueous blank by filling a 40 mL vial with reagent water and placing it in the autosampler. The autosampler will add the internal standard and/or surrogate standard.

9.1.1.2. Prepare a medium or high level blank in a 50 mL volumetric flask by adding 1.0 mL of purge and trap grade methanol to reagent water and bringing up to volume with the reagent water. The appropriate volume of this mix is added to the purge vessel. The autosampler will automatically internal standard and/or surrogate standard.

9.1.1.3. Prepare a low- level soil blank in a 40 ml VOA vial by adding a magnetic stir bar and 5 ml of reagent water and placing the vial in the autosampler tray. An additional 5mL of reagent water plus 1uL of 250ppm Internal Standard/Surrogate Mix (see Section 7.2.4) will be added by the Archon prior to purging.

9.1.1.4. To be considered acceptable, the method blank must not have any target analytes above the reporting limit. If method blanks are unacceptably contaminated with target compounds that are also present in field samples, all affected samples must be re-extracted and re-analyzed. Corrective action must be taken to identify and eliminate the contamination source. Demonstrate that acceptable blanks can be obtained before continuing with sample extraction and analysis. Method blanks must be analyzed on each instrument on which the associated samples are analyzed.

9.1.1.5. Surrogate recoveries for the method blank must be within the laboratory generated limits. Internal standard area counts in the method blank must be within method specified limits. If any surrogate or internal standard is outside the limits, the method blank must re-analyzed.

9.1.2. Matrix Spike (MS)/Matrix Spike Duplicate (MSD): A matrix spike/matrix spike duplicate (MS/MSD) pair is extracted and analyzed with every 20 environmental samples of a specific matrix (defined as a sample batch which may contain up to 20 samples, and additional samples can be added to the batch for 14 days after the first sample was analyzed). Full compound list spiking is employed for MS/MSDs and LCSs. These spikes are prepared (as described in Section 9.1.2.1) concurrent with sample preparation. MS and MSD recoveries are calculated and compared to lab generated acceptance criteria which are updated annually. For acceptance limits, reference the current TALS (LIMS) active Method Limit Group database.

9.1.2.1. Prepare the MS/MSD as follows:

9.1.2.1.1 Low Level Soil: The low level soil MS/MSD is prepared as detailed in the following table. This is prepared in duplicate (one for the MS, the other for the MSD) in a 5

ml syringe filled with reagent water. Once prepped the solution is added to separate 40 ml vials each containing 5 gram aliquots of the sample to be spiked :

Standard Solution (Reference Table 2, Lab Names)	Concentration	Volume of Standard (ul)Added to 5.0 ml of Reagent Water	Final Concentration (ug/kg)
8260C SP (Separate lot)	50ppm	2	20
MIX 3 SP (Separate lot)	5000ppm (varied)	3	3000 (varied)
GAS SP 2-Chlorethylvinylether (Separate lot)	50ppm	2	20
AC/AC/1,4-Dioxane (Separate lot)	500/250/250 ppm	3	300/150/150
Propenes (second source)	50ppm (varied)	2	20 (varied)

9.1.2.1.2 Aqueous Samples: The MS/MSD for aqueous samples is prepared as detailed in the following table. This is prepared in duplicate (one for MS, the other for MSD) in 50 ml volumetric flasks filled with an aliquot of sample to be spiked. Once prepped the solution is poured into a 40 ml VOA vial and loaded onto the purge and trap autosampler:

Standard Solution (Reference Table 2, Lab Names)	Concentration	Volume of Standard (ul) Added to 50 ml of Sample	Final Concentration (ug/L)
8260C SP (Separate lot)	50ppm	20	20
MIX 3 SP (Separate lot)	5000ppm (varied)	30	3000 (varied)
GAS SP 2-Chlorethylvinylether (Separate lot)	50ppm	20	20
AC/AC/1,4-Dioxane (Separate lot)	500/250/250 ppm	4	40/20/20
1,4-Dioxane	500ppm	13	130
Propenes (second source)	50ppm (varied)	20	20 (varied)

9.1.2.1.3 Medium & High Level Soils: The MS/MSD for medium/high level soils is prepared as detailed in the following table. This is prepared in duplicate (one for MS, the other for MSD) in 50 ml volumetric flasks filled with reagent water which has been previously spiked with the methanol sample extract. Once prepped the

solution is poured into a 40 ml VOA vial, the and loaded onto the purge and trap autosampler:

Standard Solution (Reference Table 2, Lab Names)	Concentration	Volume of Standard (ul) Added to 50 ml of Reagent Water containing sample methanol extract	Final Concentration (ug/L)
8260C SP (Separate lot)	50ppm	20	20
MIX 3 SP (Separate lot)	5000ppm (varied)	30	3000 (varied)
GAS SP 2-Chlorethylvinylether (Separate lot)	50ppm	20	20
AC/AC/1,4-Dioxane (Separate lot)	500/250/250 ppm	4	40/20/20
1,4-Dioxane (separate lot)	500ppm	13	130
Propenes (second source)	50ppm (varied)	20	20 (varied)

9.1.2.1.4 **SIM**: The MS/MSD for SIM samples is prepared as detailed in the following table. This is prepared in duplicate (one for MS, the other for MSD) in 50 ml volumetric flasks filled with an aliquot of sample to be spiked. Once prepped the solution is poured into a 40 ml VOA vial and loaded onto the purge and trap autosampler:

Standard Solution	Concentration	Volume of Standard Added to 50 ml of Reagent Water (ul)	Final Concentration (ug/L)
8260C SP (Second source)	50ppm	0.5	0.50
1,4-Dioxane (second source)	500ppm (varied)	2	20
8260C IS/SS	25ppm	1	0.5

9.1.2.2. An Laboratory Control Sample (LCS) /Laboratory Control Sample Duplicate (LCSD) may be substituted for the MS/MSD if insufficient sample volume is available (see Section 9.1.3).

9.1.3. Laboratory Control Sample (LCS)/Laboratory Control Sample Duplicate (LCSD): A Laboratory Control Sample (LCS) (aka blank spike) must be prepared analyzed with each batch of 20 environmental samples. The LCS data is used to assess method performance if the MS/MSD recoveries fall outside of the lab generated limits (see For acceptance limits, reference the current TALS (LIMS) active Method Limit Group database). If the LCS recovery is within the current lab generated

limits, the MS/MSD recoveries are attributed to matrix interference. If the LCS recovery results are outside the method specified, the LCS is reanalyzed. If, upon reanalysis, the LCS is it is still outside of limits the entire batch must be reanalyzed.

9.1.3.1 For LCS preparation instructions please refer to Section 9.1.2.1 for low level soil introduction technique (note: use reagent water only, no solid matrix is used when preparing the LCS) and Section 9.2.1.2 for aqueous/medium or high level solids introduction (note: use reagent water only, no sample or sample extract is used when preparing the LCS).

9.1.3.2 The LCS for SIM samples is prepared as detailed in the following table. This is prepared in a 50 ml volumetric flasks filled with organic free reagent water. Once prepped the solution is poured into a 40 ml VOA vial and loaded onto the purge and trap autosampler

Standard Solution	Concentration	Volume of Standard Added to 50 ml of Reagent Water (ul)	Final Concentration (ug/L)
8260C SP (Second source)	50ppm	0.5	0.50
1,4-Dioxane (second source)	500ppm	2	20
8260C IS/SS	25ppm	1	0.5

9.1.3.3 A Laboratory Control Sample Duplicate (LCSD) is analyzed only when insufficient client sample is available for preparation of an MS/MSD pair. The LCS/LSCD is evaluated in the same manner as the MS/MSD (see Section 9.1.2)

9.1.4. Surrogate Standards: All samples, blanks and QC samples are spiked with a three (3) component surrogate standard mix (see Section 7.2.2). The percent recovery of the surrogate standards is calculated and compared to lab generated limits (For acceptance limits, reference the current TALS (LIMS) active Method Limit Group database).

9.1.4.1. Surrogate recovery limits are lab generated and are updated annually.

9.1.4.2. Surrogate recoveries are calculated for the blank, samples, and QC samples. Surrogate recovery is calculated as:

$$\frac{\textbf{Concentration found}}{\textbf{Concentration added}} \times 100 = \%\ \textbf{RECOVERY}$$

9.1.4.3. If the surrogate recoveries of any blank, sample, or QC sample fails to meet the current recovery criteria, the sample must be re-analyzed. If a surrogate is diluted to a concentration below that of the lowest calibration standard, no corrective action is necessary

9.1.5. Internal Standards: All samples, blanks, standards and QC samples are spiked with a three (3) component internal standard mix (See Section 7.2.3). The response (area count) and retention time of each internal standard in all samples, standards, blanks and QC samples are monitored.

9.1.5.1. The internal standard responses must be within -50 +100% of its corresponding internal standard in the mid-level calibration standard or the active calibration curve. Failure to meet these criteria is indicative of sample matrix effects. All samples failing these criteria must be reanalyzed to confirm matrix effects.

9.1.5.2. Internal standard retention time is evaluated immediately after acquisition. The retention times of the internal standards must be within ±30 seconds of the internal standards from the mid point standard of the initial calibration or the calibration verification standard. Any blank, sample, or QC sample that fails to meet these criteria must be re-analyzed.

9.2 Instrument QC

9.2.1 GC/MS Instrument Performance Check (BFB): The GC/MS system is tuned using Perfluortributylamine (PFTBA) such that an injection or purging of 50ng of 4-Bromofluorobenzene (BFB) meets the abundance criteria listed in the table below. Prior to the analysis of any calibration standards or samples, the GC/MS system must meet all BFB key ion abundance criteria. This analysis will verify proper tuning of the system for a period of 12 hours post-injection. After 12 hours, the instrument performance must again be verified prior to the analysis of standards, QC or samples.

BFB Key Ions and Abundance Criteria	
Mass	**Ion Abundance Criteria**
50	15.0-40.0 percent of the base peak
75	30.0-60.0 percent of the base peak
95	Base peak, 100% relative abundance
96	5.0-9.0 percent of the base peak
173	Less than 2.0% of mass 174
174	Greater than 50% of the base peak
175	5.0-9.0 percent of mass 174
176	Greater than 95.0% but less than 101% of mass174
177	5.0-9.0 percent of mass 176

9.2.1.1. The BFB mass spectrum may be evaluated using one of the procedures listed below. The spectrum may be background

subtracted using a single peak no more than 20 scans before the peak apex. The BFB spectrum must meet the technical acceptance criteria listed in the table above:

- A single scan on the peak;
- An average of the peak;
- Use of three scan averaging and background subtraction techniques. Select the scan at the BFB peak apex, add +1 scan from the apex and -1 scans from the apex;

9.2.1.2. BFB parameter settings are stored in a tune file, which ill be used in all subsequent analysis of standards and samples.

9.2.2 Initial Calibration Range and Initial Calibration Verification

9.2.2.1. **Initial Calibration:** The initial calibration range consists of a five-point concentration (six points for second order regression) range of analytical standards prepared as described in Table 3/Table 3a (attached). The initial calibration range must be analyzed only after the BFB instrument performance check has met the criteria in Section 9.2.1. A separate initial calibration range is analyzed for each sample introduction technique.

9.2.2.2. If analysis by the SIM technique is required, prepare calibration standards for 1,2-dibromoethane and 1,2-dibromo-3-chloropropane at concentrations of 0.02, 0.05, 0.10, 0.50, 1.0 and 2.0 ppb; 1,4-Dioxane at 2, 5, 10, 20, 30, 40 ppb. Add surrogates/internal to each point at a concentration of 0.5ppb. See Table 5 that summarizes the preparation information.

9.2.2.3. **Initial Calibration Verification (ICV):** An Initial Calibration Verification (ICV) standard is analyzed immediately after the Initial Calibration Range and before any samples are analyzed. The ICV is prepared as detailed in Section 7.2.1.3 and Tables 4 and 4a (full scan) and Table 5 (SIM) (attached). The ICV must be from a source separate from the standards used in the Initial Calibration Range.

9.2.3 **Continuing Calibration Verification (CCV):** A approximately mid-point (50 ug/ml and 0.50ug/ml for SIM) Continuing Calibration Verification (CCV) must be analyzed every 12 hours after the BFB instrument performance check. The CCV is prepared as detailed in Section 7.2.1.1 and Table 3 (attached).

9.2.4 Calibration Acceptance Summary

9.2.4.1. **Retention Time:** The relative retention times of each compound in the five calibration standards must agree within 0.06 relative retention time units.

9.2.4.2. **Initial Calibration Range:** Internal standard calibration is employed for this method. After the initial calibration range has been analyzed as detailed in Section 10.3.3 the relative response factor (RRF) for each target/surrogate compound at each concentration level is determined using the following equation.

$$RRF = \frac{A_x}{A_{is}} \times \frac{C_{is}}{C_x}$$

Where:
A_x = Area characteristic ion for the compound (see attached Table 7)
Ais = Area characteristic ion of internal standard (see attached Table 7)
Cis = Concentration of internal standard
Cx = Concentration of compound in standard

9.2.4.2.1. Determine the mean RRF for each compound using the five or six RFs from the initial calibration range.

9.2.4.2.2. The average RFs of the target analytes listed in the table below must meet the indicated minimum RF criteria:

Minimum Relative Response Factor	
Common Target Analytes	**Minimum RF**
Dichlorodifluoromethane	0.100
Chloromethane	0.100
Vinyl Chloride	0.100
Bromomethane	0.100
Chloroethane	0.100
Trichlorofluoromethane	0.100
1,1-Dichloroethene	0.100
1,1,2-Trichloro-1,2,2-trifluoroethane	0.100
Acetone *	0.100
Carbon disulfide	0.100
Methyl Acetate *	0.100
Methylene chloride	0.100
trans-1,2-Dichloroethene	0.100
cis-1,2-Dichloroethene	0.100
Methyl tert-Butyl Ether	0.100
1,1-Dichloroethane	0.200
2-Butanone *	0.100
Chloroform	0.200
1,1,1-Trichloroethane	0.100
Cyclohexane	0.100
Carbon tetrachloride	0.100
Benzene	0.500
1,2-Dichloroethane	0.100
Trichloroethene	0.200
Methylcyclohexane	0.100
1,2-Dichloropropane	0.100

Minimum Relative Response Factor	
Common Target Analytes	**Minimum RF**
Bromodichloromethane	0.200
cis-1,3-Dichloropropene	0.200
trans-1,3-Dichloropropene	0.100
4-Methyl-2-pentanone	0.100
Toluene	0.400
1,1,2-Trichloroethane	0.100
Tetrachloroethene	0.200
2-Hexanone	0.100
Dibromochloromethane	0.100
1,2-Dibromoethane	0.100
Chlorobenzene	0.500
Ethylbenzene	0.100
meta-/para-Xylene	0.100
ortho-Xylene	0.300
Styrene	0.300
Bromoform	0.100
Isopropylbenzene	0.100
1,1,2,2-Tetrachloroethane	0.300
1,3-Dichlorobenzene	0.600
1,4-Dichlorobenzene	0.500
1,2-Dichlorobenzene	0.400
1,2-Dibromo-3-chloropropane	0.050
1,2,4-Trichlorobenzene	0.200

* Alternate ions chosen for these analytes may result in lower than recommended value.

9.2.4.2.3. Calculate the Standard Deviation (SD) and Percent Relative Standard Deviation (% RSD) of the response factors for each compound:

$$\% \text{ RSD} = \frac{\text{Standard Deviation of RRFs}}{\text{Mean RRF}}$$

The % RSD of the common target compounds listed above must be ≤20% in order for the calibration range to be acceptable. If more than 10% of the compounds exceed the 20%RSD limit and do not meet the minimum correlation coefficient (0.99) for alternative curve fits, appropriate instrument maintenance like source cleaning should be performed. Any compound that do not meet the 20%RSD or 0.99 correlation coefficient criteria must be flagged as estimated for detects.

9.2.4.2.4. For all compounds (including those analyzed by SIM): in order to assume linearity, the % RSD of the RRF's for each target analyte must be ≤20%.

9.2.4.2.5. If the above listed criteria is met, the system can be assumed to be linear, sample analysis may begin and the average RF from the initial calibration range may be used to quantitate all samples.

9.2.4.2.6. An alternative calibration technique may be employed for those any compounds exceeding the 20% RSD criteria:

9.2.4.2.7.1 Linear regression: Calculate the first order linear regression for any compound which did not meet the 20% RSD criteria. The r value (Correlation Coefficient) of the equation must be ≥0.99 for linear regression to be employed.

9.2.4.2.7.2 Quadratic (or second order) regression: may be used if the linear regression correlation coefficient exceeds criteria. Quadratic regression requires the use of a minimum six calibration points. If second order regression calibration is used, the r^2 (Correlation Coefficient) value must be ≥ 0.99

9.2.4.2.7. If neither of the alternative calibration techniques meets acceptance criteria, the calibration is not valid. Corrective action must be taken and the initial calibration range reanalyzed.

9.2.4.2.8. Due to significant bias to the lower portion of a calibration curve using the linear regression fit model a 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 as if it were an unknown sample (rename the lower point calibration file as a separate data file before re-processing). The results should be within ±30% of the standard's true concentration. This is not required for average RF or quadratic fits. Additionally forcing a linear regression through zero will meet the requirement of not re-fitting. Analytes which do not meet the minimum quantitation calibration re-fitting criteria should be considered 'out of control'. Report those target analyte outliers as estimated when the concentration is at or near the lowest calibration point and/or report to the next reporting level (i.e., the next higher calibration point for the analyte).

9.2.4.2.9. For additional detail refer to TestAmerica Edison Work Instruction No. EDS-WI-096, *8260C ICAL Procedure*, latest revision.

9.2.4.3. Initial Calibration Verification (ICV): Once the initial calibration has been analyzed and has met the above criteria, a

second source Initial Calibration Verification (ICV) (as prepared in Section 9.2.2.2) must be analyzed and evaluated. The ICV must meet the criteria of 70-130% recovery for all compounds however up to 20% of the compounds are allowed to exceed this criteria as long as their recoveries are within 65-135%. If the criterion is not met, a second ICV may be analyzed after corrective measures are taken. If a second ICV analysis fails to meet criteria proceed with corrective action and the analysis of a new initial calibration range.

9.2.4.4. **Continuing Calibration Verification (CCV):** A CCV consisting of a standard at or near the midpoint of the Initial Calibration Range is analyzed every 12 hours of instrument operation or at the beginning of an analytical sequence to verify the initial calibration. The calibration verification consists of a BFB instrument performance check, and analysis of a calibration verification standard.

9.2.4.4.1 Tune Verification: Follow the procedure for verifying the instrument tune described in section 9.2.1 using a 50 ng injection of BFB. If the tune cannot be verified, analysis must be stopped, corrective action taken and a return to "control" demonstrated before continuing with the calibration verification process.

9.2.4.4.1.1 Calibration Verification: Analyze the calibration verification standard immediately after a BFB that meets criteria. Use the mid point calibration standard (20ug/L). **NOTE:** The same sample introduction technique employed for the initial six-point calibration must be used for the calibration verification.

9.2.4.4.1.2 Calculate response factors (RF) for each compound using the internal standard method.

9.2.4.4.1.3 The RFs must meet the minimum RF criteria listed in the table in Section 9.2.4.2.2.

9.2.4.4.1.4 Calculate the % Difference for each response factor in the calibration check standard vs. the response factors from the initial calibration.

9.2.4.4.1.5 If the percent difference/drift (%D) for the compounds listed in the table in Section 9.2.4.2.2 is ≤20%, the initial calibration is assumed to be valid. If the ≤20% D criteria is not met for more than 20% of the compounds in the initial calibration, corrective action/

investigation may be taken. After corrective action, another calibration verification standard may be injected. If the response for the analyte is still not ≤20%, a new initial calibration range must be generated.

9.2.4.4.1.6 For compounds that fail the 20%D criterion adequate sensitivity may be demonstrated by including a low level standard in the analytical batch. If all the analytes are detected, proceed for non-detects. If the failed compound is present in the samples the concentrations must be reported as estimated values.

9.2.4.4.1.7 Percent drift is used instead of percent difference in calibrations employing either the linear or second order regression modes.

9.2.4.4.1.8 For the compounds not listed in the table in Section 9.2.4.2.2: No one individual compound of interest may exceed 50%D. For SIM analysis the %D is 50%.

9.2.4.4.1.9 The retention times of the internal standards from the calibration check must be within ±30 seconds of the internal standards from the mid point standard of the original calibration. If the retention time for any internal standard changes by more than 30 seconds from the latest daily (12 hour) calibration standard, the chromatographic system is inspected for malfunctions, and corrections made as required. If corrective action does not result in the retention time criteria being achieved, the system must be re-calibrated using four additional standards.

9.2.4.4.1.10 Internal standard area response is also evaluated immediately after acquisition. The response (area count) of each internal standard in the calibration verification standard must be within 50% - 100% of its corresponding internal standard in the mid-level calibration standard of the initial calibration curve. If the EICP area for any internal standard changes by more than a factor of two (-50% to +100%), the mass spectrometer system must be inspected for malfunction and corrections made as appropriate. When corrections are made, re-

analysis of samples analyzed while the system was malfunctioning is required.

10.0 Procedure

10.1. Gas Chromatograph/Mass Spectrometer Operation

10.1.1. The instrument operating parameters are set as follows at the beginning of a method of analysis and remain constant throughout the entire analytical procedure

10.1.1.1 Full Scan Operating Mode

Purge and trap unit

Purge Time:	11 minutes
Dry Purge:	1 Minutes
Purge Gas:	Nitrogen
Purge Flow:	40-45 ml/min
Purge Temp:	Water: Ambient; Solids: 40°C
Trapping Temp:	Ambient, <30°C
Desorb Time:	1 Minute
Desorb Temp:	VOCARB: 260°C, #10: 190°C

Gas chromatograph

Injector:	180°C
Carrier Gas:	Helium
Carrier Flow:	6 ml/min, 6890: 0.8 ml/min
Oven Program:	40°C for 1 min, 8°C/min to 90°C, 20°C/ min to 250°C for 3 min; 6890: 40°C for 1 min, 8°C/min to 100°C, 24°C/min to 220°C for 2 min
Run Time:	15 - 20 Minutes

Mass Spectrometer

Electron Energy:	70 volts (nominal)
Mass range:	35-260 AMU
Scan time:	0.9 sec./scan
Source Temp:	200°C
Separator Temp:	180°C

10.1.1.2 SIM Operating Mode

Purge and trap unit

Purge Time:	11 minutes
Dry Purge:	1 Minutes
Purge Gas:	Nitrogen
Purge Flow:	40-45 ml/min
Purge Temp:	Water: Ambient; Solids: 40°C
Trapping Temp:	Ambient, <30°C
Desorb Time:	1 Minute
Desorb Temp:	VOCARB: 260°C, #10: 190°C

Gas chromatograph

Injector:	180°C
Carrier Gas:	Helium
Carrier Flow:	6 ml/min, 6890: 0.8 ml/min
Oven Program:	40°C for 1 min, 8°C/min to 90°C, 20°C/ min to 250°C for 3 min; 6890: 40°C for 1 min, 8°C/min to 100°C, 24°C/min to 220°C for 2 min
Run Time:	15 - 20 Minutes

Mass Spectrometer

Electron Energy:	70 volts (nominal)
Mass range:	35-260 AMU
Scan time:	0.9 sec./scan
Source Temp:	200°C
Separator Temp:	180°C

SIM Parameters:

Group 1
Plot 1 Ion: 51.0/96

Ions/Dwell in Group	(Mass	Dwell)	(Mass	Dwell)	(Mass	Dwell)
	51.0	100	58.0	100	65.0	100
	67.0	100	70.0	100	88.0	100
	96.0	100				

Group 2
Group Start Time: 6.20
Plot 1 Ion: 82/117

Ions/Dwell in Group	(Mass	Dwell)	(Mass	Dwell)	(Mass	Dwell)
	82.0	100	107.0	100	109.0	100
	117.0	100				

Group 3
Group Start Time: 8.50
Plot 1 Ion: 75/157

Ions/Dwell in Group	(Mass	Dwell)	(Mass	Dwell)	(Mass	Dwell)
	75.0	100	95.0	100	150.0	100
	152.0	100	152.0	100	157.0	100
	174.0	100				

10.2. Sample Preparation

10.2.1. Screening: All samples extracts must be screened by GC/FID static headspace analysis to provide the analyst with appropriate initial dilution factors. For additional details see TestAmerica Edison SOP No. ED-GCV-001, *Screening for Volatile Organics, Static Headspace with GC FID, SW846 Method 5021*, current revision.

10.2.2. Aqueous Samples: Unopened 40 mls vials with aqueous samples are placed in an Archon autosampler. 1 uL of Internal Standard/Surrogate Mix (see Section 7.2.4) is added by the Archon as the 5 mL of the sample passes through the sample loop.

10.2.3. Medium or high level soils: Medium or high level extracts that will be run on an Archon autosampler are prepared in 50mL volumetric flasks. The Archon can be set up to add 1uL of 250ppm Internal Standard/Surrogate Mix (see Section 7.2.4) to each sample as the 5mL portion passes through the sample loop.

10.2.4. Low level soils: Low level soils must be run on an Archon autosampler. 1uL of 250ppm Internal Standard/Surrogate Mix (see Section 7.2.4) and 5mL reagent water is added to each sample vial by the Archon immediately before the sample is purged.

10.3. Instrument Performance and Calibration Sequence

10.3.1. Once the GC/MS instrument has been setup and maintained as detailed in Section 10.1, the first operations to be performed are the performance checks and calibration standards.

10.3.2. Analyze the Instrument Performance Check Standard (BFB) as discussed in Section 9.2.1.

10.3.3. A unique initial calibration is then prepared for each sample introduction technique.:

10.3.3.1 40 ml VOA Vial (Aqueous/Medium-High Level Soils): Prepare aqueous calibration standards at six concentration levels for each parameter by adding the volumes of working standards listed in Table 3 to a 50mL volumetric flask of reagent

water. Pour the calibration standards into 40mL VOA vials and load into the autosampler tray. If the internal standard is to be added by the Archon/OI autosamplers the addition of internal standard into the 50ml volumetric flaks may be omitted.

10.3.3.2 **40 ml VOA Vial (Low Level Soils):** If the calibration is for low-level soils prepared according to Method 5035, the calibration standards must be prepared by adding the volumes of working standards listed in Table 3 into a 5 mL syringe filled with reagent water and pouring the prepared standards into 40 mL VOA vials containing a magnetic stir bar.

10.3.4. Purge the standard for 11 minutes.

10.3.5. After purging is complete, desorb the sample onto the GC column by rapidly heating the trap to 260°C for VOCARB, 190°C for #10 and backflushing it with helium.

10.3.6. Begin the GC temperature program and data acquisition.

10.3.7. Re-condition the trap by baking for 12 minutes at 260°C for VOCARB, 210°C for #10.

10.3.8. Cool the trap to (<31°C). The trap is now ready for the next sample.

10.3.9. Transfer data to network, and process using TARGET software.

10.4. Sample Analysis Sequence

10.4.1. Once the initial calibration has been verified by successful analysis of an ICV and Method Blank, analysis of samples may begin.

10.4.2. Samples must be analyzed under the same instrument conditions and using the same injection volume as the calibration standards.

10.4.3. Equilibrate all samples to room temperature prior to analysis.

10.4.4. If the sample concentration exceeds that of the range, the sample must be diluted and re-analyzed.

10.4.5. The analytical run log is printed as a record of samples analyzed. The analyst will annotate the run log with any required information regarding anomalies or unusual events. The run log must be signed by the analyst and a reviewed and signed by a trained peer or manager

10.5. Data Processing

10.5.1. Prior to processing any standards or samples, target compound lists and sublists must be assembled in the Target system. These lists are required for processing of all data files including calibration files. The data includes

compound names, retention time data, quantitation ions, qualitative identification ions, and the assigned internal standard for qualitative and quantitative identification.

10.5.2. Key data is manually entered the first time a compound list is used for data processing. Processing data using a compound list automatically generates response factor data and updates retention information.

10.5.3. Data is transferred from the acquisition PC to the network for processing with TARGET software.

10.5.4. Each data file is checked for correct information including sample number, job number, QA batch, dilution factor, initial volume, final volume, and % moisture.

10.5.5. Each sample is checked against a department work list for the correct sublist of target analytes.

10.5.6. Each data file is processed using calibration factors from the most recent initial calibration, quantitation from the daily calibration verification standard is not permitted.

10.5.7. The characteristic ions for target compounds, surrogate compounds, and internal standards which can be determined using SW8260CB are listed in Table 7.

10.6. Interpretation and Qualitative Identification:

10.6.1 Target Analytes: Qualitative identification of target compounds is based on retention time and mass spectral comparison with characteristic ions in the target compound list. The reference mass spectrum is taken from a standard of the target compound analyzed by this method. The characteristic ions are 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:

10.6.1.1. Once the GC/MS instrument has been setup and maintained as detailed in Section 10.1, the first operations to be performed are the performance checks and calibration standards.

10.6.1.2. The intensities of the characteristic ions of a compound maximize in the same scan or within one scan of each other.

10.6.1.3. The relative retention time (RRT) of the sample component is within ± 0.06 RRT units of the RRT of the standard component.

10.6.1.4. The most abundant ion in the standard target spectrum that equals 100% MUST also be present in the sample target spectrum.

10.6.1.5. All other ions that are greater than 10% in the standard target spectra should also be present in the sample.

10.6.1.6. 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%).

10.6.1.7. Structural isomers that produce very similar mass spectra should be identified as individual isomers if they have sufficiently different GC retention times. Otherwise, structural isomers are identified as isomeric pairs.

10.6.1.8. If the compound does not meet all of the criteria listed above, but is deemed a match in the technical judgment of the mass spectral interpretation specialist, the compound will be positively identified and reported with documentation of the identification noted in the raw data record.

10.6.2 Non-Target Analytes: Upon client request a library search to identify non-target Tentatively Identified Compounds (TIC) is performed. The NIST/EPA/NIH mass spectral library is used to identify non-target compounds (not including internal standard and surrogate compounds) of greatest apparent concentration by a forward search of the library. The following guidelines are used by the analyst when making TIC identifications:

10.6.2.1 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.

10.6.2.2 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%).

10.6.2.3 Molecular ions present in the reference spectrum should be present in the sample spectrum.

10.6.2.4 Ions present in the sample spectrum but not in the reference spectrum should be reviewed for possible background contamination or presence of co-eluting compounds.

10.6.2.5 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 co-eluting peaks. Data system library reduction programs can sometimes create these discrepancies.

10.6.2.6 If, in the technical judgement of the mass spectral interpretation specialist, no tentative identification can be made, the compound will be reported as 'Unknown'. If the compound can be further classified the analyst may do so (i.e, 'Unknown hydrocarbon', 'Unknown acid' , etc..).

10.7. Data Reporting

10.7.1. Final Report. The Target system automatically produces a data report consisting of key, hardcopy reports corresponding to specific data reporting requirements. Standard reports consist of multiple pages that the analysts must compile and organize for the report production group.

10.7.1.1. Total Ion Chromatogram. Full length chromatogram depicting the full length of the GC/MS acquisition.

10.7.1.2. Spectra of all detected target compounds. A page for each detected target compound spectra with a standard reference spectrum for comparison.

10.7.1.3. The calculations of the concentrations of each target compound in the sample, reported in units of ppb, ug/kg or ug/l.

10.7.1.4. Data summaries for each method blank indicating which samples were extracted with the indicated blank.

10.7.1.5. A copy of the initial calibration range together with the calibration verification report, and tune report.

10.7.1.6. Quality Control (QC) data report for each batch including surrogate recoveries, internal standard area summaries, LCS, MS/MSD and RPD summaries.

11.0. Calculations / Data Reduction

11.1. Target Compounds: are quantitated using the internal standard method.

11.1.1. Identified target compounds are quantitated using the integrated abundance from the EICP of the primary characteristic ion. The internal standard used shall be the one nearest the retention time of the analyte).

11.1.2. The average response factor (RRF) from the initial calibration is used to calculate the target analyte concentration in client samples using the formula found in Section 11.3.. See Section 9.2.4.2 for discussion of RRF.

11.1.3. Secondary ion quantitation is utilized only when there are sample interferences preventing use of the primary characteristic ion. If secondary ion quantitation is used an average relative response factor (RRF) must be calculated using that secondary ion.

11.1.4. Aqueous Samples

$$\text{Concentration } (\mu g/L) = \frac{(As)(Cis)(D)}{(Ais)(RRF)(Vs)}$$

Where:

As	=	Area of the characteristic ion for the target analyte in the sample
Cis	=	Concentration of the internal standard (ug/L)
D	=	Dilution factor, if the sample or extract was diluted prior to analysis. If no dilution is performed, D = 1.
Ais	=	Area of the characteristic for the associated internal standard
RRF	=	Average relative response factor from the initial calibration.
Vs	=	Volume of sample purged (ml)

11.1.5. Low Level Solid Samples

$$\text{Concentration } (\mu g/Kg) \text{ (dry wt)} = \frac{(As)(Cis)}{(Ais)(RRF)(Ws)\ (DW)}$$

Where:

As	=	Area of the characteristic ion for the target analyte in the sample
Cis	=	Concentration of the internal standard (ug/L)
DW	=	Dry wt correction = $\frac{100 - \%\ \text{moisture}}{100}$

Ais = Area of the characteristic for the associated internal standard

RRF = Average relative response factor from the initial calibration.

Ws = Weight of sample purged (g)

11.1.6. Medium Level Solid Samples

$$\text{Concentration } (\mu g/Kg) \text{ (dry wt)} = \frac{(As)(Cis)(Vt)(1000)(D)}{(Ais)(RRF)(Va)(Ws)(DW)}$$

Where:

As = Area of the characteristic ion for the target analyte in the sample

Cis = Concentration of the internal standard (ug/L)

D = Dilution factor, if the sample or extract was diluted prior to analysis. If no dilution is performed, D = 1

DW = Dry wt correction = $\frac{100 - \%\ \text{moisture}}{100}$

Ais = Area of the characteristic for the associated internal standard

RRF = Average relative response factor from the initial calibration.

Va = Volume of the aliquot of sample methanol extract added to reagent water for purging in ul

Vt = Total volume of methanol extract in milliliters

Ws = Weight of sample purged (g)

11.2. Non-Target Compounds (Tentatively Identified Compounds): An estimated concentration for non-target (tentatively identified compounds) is calculated using the internal standard method . For quantiation, the nearest eluting internal standard free of interferences is used. The procedure used for calculating the concentration of non-target compounds is the same as that used for target compounds (see Section 11.1) with the following revisions:

11.2.1. The total area count of the non-target compound is used for As (instead of the area of a characteristic ion).

11.2.2. The total area count of the chosen internal standard is used as Ais (instead of the area of a characteristic ion).

11.2.3. A RF on 1.0 is assumed.

11.2.4. The resulting concentration is qualified as estimated ('J') indicating the quantitative uncertainties of the reported concentration.

11.3. Relative Response Factors

$$RRF = \frac{A_x}{A_{is}} \times \frac{C_{is}}{C_x}$$

Where:

A_x = Area characteristic ion for the compound (see Table 7)
Ais = Area characteristic ion of associated internal standard (See Table 7)
Cis = Concentration of internal standard
Cx = Concentration of compound in standard

11.4. Percent Relative Standard Deviation (% RSD) : as discussed in Section 9.2.4.2. (Initial calibration):

$$\% \text{ RSD} = \frac{\text{Standard Deviation of RRFs}}{\text{Mean RRF}}$$

11.5. Percent Difference (% D):as discussed in Section 9.2.4.4 (Continuing calibration):

$$\% D = \frac{RRF_c - \overline{RRF_i}}{\overline{RRF_i}} X\ 100$$

Where: RRFc = RRF from continuing calibration

$\overline{RRF_i}$ = Mean RRF from current initial calibration

11.6. Percent Recovery (% R): Surrogates and Spikes

$$\text{Recovery (\%)} = \frac{\text{Concentration (or amount) found}}{\text{Concentration (or amount) added}} \times 100$$

11.7. Dry Weight Correction: All solid samples must be corrected for dry weight using the following formula for dry weight determination.

$$DW = \frac{Gd}{Gw} \times 100$$

Where:

DW	=	Percent % Dry Weight
Gd	=	Dry weight of selected sample aliquot
Gw	=	Wet weight of selected sample aliquot

Multiply the DW value times the wet weight of the sample extracted. NOTE: This calculation can also be performed automatically by the target system provided the DW value is available and entered into the system.

11.8. Accuracy:

$$\text{ICV , CCV and LCS \% Recovery} = \frac{\text{observed concentration}}{\text{known concentration}} \times 100$$

$$\text{MS \% Recovery} = \frac{\text{(spiked sample) - (unspiked sample)}}{\text{spiked concentration}} \times 100$$

11.9. Precision (RPD):

$$\text{Matrix Duplicate (MD)} = \frac{|\text{orig. sample value - dup. sample value}|}{[(\text{orig. sample value + dup. sample value})/2]} \times 100$$

12.0 Method Performance

12.1. Method Detection Limit Study (MDL)

The method detection limit (MDL) is the lowest concentration that can be detected for a given analytical method and sample matrix with 99% confidence that the analyte is present. The MDL is determined according to the laboratory's MDL procedure in Section 20 (Test Methods and Method Validation) of TestAmerica Edison's Quality Assurance Manual (ED-QA-LQM). MDLs reflect a calculated (statistical) value determined under ideal laboratory conditions in a clean matrix, and may not be achievable in all environmental matrices. The laboratory maintains MDL studies for analyses performed; these are verified at least annually unless method requirements require a greater frequency.

12.2. Demonstration of Capabilities

For DOC procedure refer to Section 20 in the most current revision of TestAmerica Edison's Quality Assurance Manual (ED-QA-LQM).

12.3. Training Requirements

Refer to TestAmerica Edison SOP No. ED-GEN-022, *Training*, current revision for the laboratory's training program.

13.0 Pollution Control

13.1. 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 Environmental Health and Safety Manual (CW-E-M-001) for "Waste Management and Pollution Prevention."

14.0 Waste Management

14.1. 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 TestAmerica Edison SOP No. ED-SPM-008, *Laboratory Waste Disposal Practices*, current revision. The following waste streams are produced when this method is carried out.

- Laboratory Generated Aqueous Waste (aqueous VOA vials – used and unused). This waste may have a pH of less than 2.0. These vials are collected in satellite accumulation. The vials are then transferred to the waste room. These vials are passed through a vial crusher and the liquid portion is separated from the solid portion. The solid is dumped into the municipal garbage. The liquid is pumped into the neutralization system where it is neutralized to a pH of 6 to 9 with sodium bicarbonate (Seidler Chemical SC-0219-25). When neutralization is complete, the material is transferred to the municipal sewer system.

- Expired Standards – The vials are collected in a 1 gallon polyethylene bucket. These vials are then transferred to an open top 55 gallon steel or polyethylene waste drum. These drums are transported to a waste facility for proper disposal.

- Soil Retain Samples - These samples if not flagged in the system for any hazardous constituents are transferred to poly-lined cubic yard boxes. These boxes when full are sent to stabilization or incineration. These materials are sent out as hazardous for lead and chromium

  Teris Profile Number (incineration): 50016710
  Onyx Profile Number: (stabilization) 402535

- Methanol Preserved Samples/Returned Methanol Preservative - Methanol preserved sample vials are collected in satellite accumulation and then transferred to a 55 gallon open top steel waste drum in the waste room. This drum is then removed by a waste vendor for incineration.

  Teris Profile Number: 50016652
  Onyx Profile Number: 282493

15.0 References / Cross-References

15.1. United States Environmental Protection Agency, "Method SW8260C, Volatile Organic Compounds by Gas Chromatography/Mass Spectrometry (GC/MS)", Test Methods for Evaluating Solid Wastes, SW846, August 2006.

15.2 United States Environmental Protection Agency, "Method SW8000C: Determinative Chromatographic Separations", Test Methods for Evaluating Solid Wastes, SW846, Laboratory Manual, Physical/Chemical Methods, Revision 3, March 2003.

15.3 TestAmerica Edison Document No. ED-QA-LQM, *Laboratory Quality Manual*, most current revision.

15.4 TestAmerica Edison SOP Nos. ED-MSV-001, *Purge and Trap for Aqueous Samples, SW846 Method 5030*, current revision.

15.5 TestAmerica Edison ED-MSV-002, *Closed-System Purge-and-Trap and Extraction for Volatile Organics in Soil and Waste Samples, SW846 Method 5035,* current revision.

15.6 TestAmerica Edison SOP No. ED-GCV-001, *Screening for Volatile Organics, Static Headspace with GC FID, SW846 Method 5021*, current revision.

15.7 TestAmerica Corporate Quality SOP No. CA-Q-S-001, *Solvent & Acid Lot Testing & Approval*, current revision.

15.8 TestAmerica Edison SOP No. ED-GEN-023, *Bulk Solvent Testing and Approval*, current revision.

15.9 TestAmerica Edison SOP No. ED-GEN-008, *Standard Operating Procedure for Preparation, Purity and Storage of Reagents and Standards*, current revision

15.10 TestAmerica Edison SOP No. ED-SPM-004, *Sample Storage & Handling Procedures for Mitigation of Sample and Laboratory Contamination,* current revision

15.11 TestAmerica Edison Work Instruction No. EDS-WI-096, *8260C ICAL Procedure*, current revision.

15.12 TestAmerica Edison SOP No. ED-GCV-001, *Screening for Volatile Organics, Static Headspace with GC FID, SW846 Method 5021*, current revision

15.13 TestAmerica Edison SOP No. ED-GEN-022, *Training*, current revision.

15.14 TestAmerica Edison SOP No. ED-SPM-008, *Laboratory Waste Disposal Practices*, current revision

16.0 Method Modifications:

N/A

17.0 Attachments

N/A

18.0 Revision History

- Revision 1, dated 09/16/2011:

  - Tables 1 and 7: added cyclopentene, 2-chloro-1,3-butadiene, methacrylonitrile, propionitrile, ethyl methacrylate, 2-nitropropane, indan and isobutyl alcohol to list of target compounds and list of standards sources.

  - Section 7.2.1 and Table 2: Table in Section 7.2.1 and Table 2 updated to include complete list of standards currently in use as well as to update vendor catalog number for several items.

  - Table 3: Initial Calibration Standards Preparation: is now split into three tables to include aqueous low level analysis.

  - Table 5: added following footnote:
    Levels 1 and 2 respectively are prepared in 500ml and 100ml final volumes
    [1]This level is also used as the Continuing Calibration Verification.

- Revision 0, dated 02/15/2011: New

Table 2: Working Standards Preparation							
Target Compound Standard Name	**Lab Name**	**Vendor**	**Cat. #**	**Vol. Std. Added**	**Conc. of Stock Std.**	**Concentration of Standard**	**Final Vol/ Total vol of MeOH**
Gas Mix	Gas (Hi)	Supelco	48799U	7.50 mL	2000ppm	500ppm	30mL 22.5mL TV/M
Gas Mix	Gas (Li)	Supelco	48799U	500 uL	2000ppm	50ppm	20mL 19.5mL TV/M
8260C Mix 1*	Mix 1 (Hi)	Supelco	5-02111	10.0 ml	2000ppm	500ppm	40mL 30mL TV/M
8260C Mix 1*	Mix 1 (Li)	Supelco	5-02111	1.0 ml	2000ppm	50ppm	40ml 39ml TV/M
Ketone Mix		Absolute	82402	500 ul	2000ppm	50ppm	20ml 19.5ml TV/M
8260C Mix 5* 8260C Mix 6 * 2-Chlorethylvinylether* Extra compound mix *	Mix 2 (Hi)	Supelco Supelco	86-1323 86-1309 86-1206 XQ-3840	10ml 10ml 10ml 1ml	2000ppm 20000ppm	500ppm	40mL 9.0mL TV/M
8260C Mix 5* 8260C Mix 6* 2-Chlorethylvinylether* Extra compound mix *	Mix 2 (Li)	Supelco SPEX	86-1323 86-1309 86-1206 XQ-3840	1ml 1ml 1ml 100ul	2000ppm 20000ppm	50ppm	40mL 36.9mL TV/M
Alcohols*	MIX 3	SPEX	VO-TANJ-4	4ml	50000ppm (varied)	5000ppm (varied)	40mL 36mL TV/M
Acrolein/Acrylonitrile/ Dioxane *	AC/AC /1,4-Dioxane	SPEX	VO-TANJ-3	4ml	20000ppm	500/250/ 250ppm	40ml 36ml TV/M
Propenes*	Propenes	Supelco	21240202	NA	1000/2000 ppm	NA	NA
Propenes*	Propenes	Supelco	21240202	1ml	1000/2000 ppm	50ppm (varied)	20ml/ 19ml
Isobutyl Alcohol	IBA	Absolute	70445	NA	1000ppm	NA	NA
Methacrylonitrile, 2-Chloro-1,3-butadiene, Ethly methacrylate, Propionitrile, Cylcopentene, 2-Nitropropane Indan	NA	Absolute	70442 70483 70381 70349 70519 70461 70955	NA	1000ppm	NA	NA

Table 2: Working Standards Preparation

Target Compound Standard Name	Lab Name	Vendor	Cat. #	Vol. Std. Added	Conc. of Stock Std.	Concentration of Standard	Final Vol/ Total vol of MeOH
8260C Mix 1 (2nd source)* 8260C Mix 5 (2nd source) * 8260C Mix 6 (2nd source) * Extra Compound mix (2nd source)*	8260C SP	Supelco SPEX	5S02111 8S61323 8S61309 VO-TANJ-8	1ml 1ml 1ml 1ml	2000ppm 2000ppm	50ppm	40mL 36.0mL TV/M
Alcohols (2nd source)*	MIX 3 SP	SPEX	VO-TANJ-4	4ml	50000ppm (varied)	5000ppm (varied)	40mL 36mL TV/M
Gas Mix 2-Chlorethylvinylether (2nd source)*	GAS SP	Supelco	4S8799U 8S61206	1ml 1ml	2000ppm	50ppm	40mL 38mL TV/M
Acrolein/Acrylonitrile/ Dioxane (2nd source)*	AC/AC SP	SPEX	VO-TANJ-3	4ml	20000ppm	500/250 ppm	40ml 36.0TV/M
8260C Mix 1* (SIM)	SIM MIX1	Supelco	5-02111	50ul	2000ppm	10ppm	10ml 9.95 TV/M
Propenes (2nd source)*	Propene SP	SPEX	XQ-4113 XQ-4114	1ml	1000/2000 ppm	50ppm (varied)	20ml/ 19ml
1,4-Dioxane	1,4-Dioxane	Supelco	360481	483.6 ul	Neat	50000ppm	10ml/9.52 TVM
1,4-Dioxane	1,4-Dioxane	Supelco	NA	100ul	50000ppm	500ppm	10ml/9.90 TVM
1,4-Dioxane (2nd source)	1,4-Dioxane	Absolute	93501	1ml	5000ppm	500ppm	10ml/9ml TV/M
Isobutyl Alcohol (SS)	IBA	Absolute	70445	NA	1000ppm	NA	NA
Methacrylonitrile,(SS) 2-Chloro-1,3-butadiene (SS) Ethly methacrylate(SS) Propionitrile (SS) Cylcopentene (SS) 2-Nitropropane (SS) Indan (SS)	NA	Absolute	70442 70483 70381 70349 70519 70461 70955	NA	1000ppm	NA	NA

Asterisk (*) indicates a custom standard mix.

Table 3: Initial Calibration Standards Preparation, Low Level Soil

Standard Solution	Final Volume Reagent Water (ml)	Volume of Standard Added to Reagent Water (ul)					
		1ppb *	5ppb*	20ppb	50ppb[1]	200ppb	500ppb
Gas Mix (50ppm)	5	0.1	0.5	2.0	5	-	-
	50	1.0	5.0	20.0	50	-	-
Gas Mix (500ppm)	5	-	-	-		2.0	5.0
	50	-	-	-		20.0	50.0
Mix 1 (Li) (50ppm)	5	0.1	0.5	2.0	5	-	-
	50	1.0	5.0	20.0	50	-	-
Mix 1 (Hi) (500ppm)	5	-	-	-	-	2.0	5.0
	50	-	-	-	-	20.0	50.0
Ketone Mix (50 ppm)	5	0.9	1	-	-	-	50.0
	50	9.0	10.0	-	-	-	500.0
Mix 2 (Li) (50ppm)	5	0.1	0.5	2.0	5	-	-
	50	1.0	5.0	2.0	50	-	-
Mix 2 (Hi) (500ppm)	5	-	-	-	-	2.0	5.0
	50	-	-	-	-	20.0	50.0
Mix 3 (varied)	5	1.0	2.0	3.0	4.0	5.0	6.0
	50	10.0	20.0	30.0	40.0	50.0	60.0
AC/AC/1,4-Dioxane (500/250/250ppm)	5	1.0	2.0	3.0	4.0	5	6.0
	50	10.0	20.0	30.0	40.0	50.0	60.0
Propenes	5	0.1	0.5	2.0	5.0	20	50
	50	1.0	5.0	20.0	50	200	500

*Ketones are at 10ppb and 15ppb in levels 1 and 5 respectively
[1]**This level is also used as the Continuing Calibration Verification.**

Table 3a: Initial Calibration Standards Preparation, Aqueous

Standard Solution	Volume of Standard Added to Reagent Water (ul)					
	1ppb*	**5ppb***	**20ppb[1]**	**50ppb**	**200ppb**	**500ppb**
Gas Mix (500ppm)	1	1	2	5	20	50
Mix 1 (Hi) (500ppm)	1	1	2	5	20	50
Mix 2 (Hi) (500ppm)	1	1	2	5	20	50
Mix 3 (varied)	100	40	30	40	50	60
AC/AC/1,4-Dioxane (500/250/250ppm)	4	4	4	10	20	40
1,4-Dioxane (500ppm)	48	18	13	15	15	10
Ketones	90	20	NA	NA	NA	NA
Propenes (1000/2000ppm)	0.5	0.5	1	2.5	10	25
Methanol Compensate	2303	433	210	185	120	0
Final vol. (reagent water)	**500 ml**	**100ml**	50 ml	50ml	50ml	50ml

*Ketones are at 10ppb and 15ppb in levels 1 and 5 respectively and are prepared in 500ml and 100ml final volumes

[1]**This level is also used as the Continuing Calibration Verification.**

Table 3b: Initial Calibration Standards Preparation, Aqueous (LOW LEVEL)

Standard Solution	Volume of Standard Added to Reagent Water (ul)					
	0.5ppb*	1ppb*	20ppb[1]	50ppb	200ppb	500ppb
Gas Mix (500ppm)	0.5	1	2	5	20	50
Mix 1 (Hi) (500ppm)	0.5	1	2	5	20	50
Mix 2 (Hi) (500ppm)	0.5	1	2	5	20	50
Mix 3 (varied)	5.0	100	30	40	50	60
AC/AC/1,4-Dioxane (500/250/250ppm)	2	4	4	10	20	40
1,4-Dioxane (500ppm)	24	48	13	15	15	10
Ketones	45	90	NA	NA	NA	NA
Propenes (1000/2000ppm)	0.25	0.5	1	2.5	10	25
Methanol Compensate	2303	433	210	185	120	0
Final vol. (reagent water)	**500 ml**	**500ml**	50 ml	50ml	50ml	50ml

*Ketones are at 10ppb and 15ppb in levels 1 and 5 respectively and are prepared in 500ml and 100ml final volumes

[1]**This level is also used as the Continuing Calibration Verification.**

Table 4 : ICV Standard Preparation, Low Level Soil

Standard Solution	Concentration	Volume of Standard Added to 5.0 ml of Reagent Water (ul)	Final Concentration (ug/L)
8260C SP (LCS) (Separate lot)	50ppm	2	20
MIX 3 (LCS) (Separate lot)	5000ppm (varied)	3	3000
AC/AC/1,4-Dioxane	500/250/250ppm	3	300/150/150
Gas SP 2-Chlorethylvinylether (LCS) (Separate lot)	50ppm	2	20
Propenes (second source)	50ppm (varied)	2	20 (varied)

Table 4a: ICV Standard Preparation, Aqueous

Standard Solution	Concentration	Volume of Standard Added to 50 ml of Reagent Water (ul)	Final Concentration (ug/L)
8260C SP (LCS) (Separate lot)	50ppm	20	20
MIX 3 (LCS) (Separate lot)	5000ppm (varied)	30	3000
AC/AC/1,4-dioxane SP	500/250/250ppm	4	40/20/20
Gas SP 2-Chlorethylvinylether (LCS) (Separate lot)	50ppm	20	20
1,4-Dioxane SP	500ppm	13	130
Propenes (second source)	50ppm (varied)	20	20 (varied)

Table 5: SIM Initial Calibration Standards Preparation

Standard Solution	Volume of Standard Added to Reagent Water (ul)					
	2 0.02ppb	5 0.05ppb	10 0.1ppb	20[1] 0.50ppb	30 1ppb	40 2ppb
Mix 1 (SIM) (10ppm)	1	0.5	0.5	2.5	5	10
1,4-Dioxane @ 500ppm	2	1	1	2	3	4
8260CIS/SS @ 25ppm	10	2	1	1	1	1
Final Volume (reagent water)	**500ml**	**100ml**	**50ml**	**50ml**	**50ml**	**50ml**

levels 1 and 2 are respectively prepared in 500ml and 100ml final volumes

[1]**This level is also used as the Continuing Calibration Verification.**

Table 6 : SIM ICV/LCS/MS/MSD Standard Preparation

Standard Solution	Concentration	Volume of Standard Added to 50 ml of Reagent Water (ul)	Final Concentration (ug/L)
8260C SP (Second source)	50ppm	0.5	0.50
1,4-Dioxane SP	500ppm (varied)	2	20
8260C IS/SS	25ppm	1	0.5

TABLE 7
Characteristic Ions of Volatile Organic Compounds

Parameter	Primary ion	Secondary ion
1,1,1-Trichloroethane	97	99,117,119
1,1,2,2-Tetrachloroethane	83	85,131,133,166
1,1,2-Trichloroethane	97	83,85,99,132,134
1,1-Dichloroethane	63	65,83,85,98,100
1,1-Dichloroethene	96	61,98
1,1-Dichloropropene	75	110. 77
1,2,3-Trichlorobenzene	180	182
1,2,3-Trichloropropane	110	75
1,2,4-Trichlorobenzene	180	182, 145
1,2,4-Trimethylbenzene	105	120
1,2-Dibromo-3-Chloropropane	75	155, 157
1,2-Dibromomethane	107	109
1,2-Dichloroethane	62	64,100,98
1,2-Dichloroethene	96	61,98
1,2-Dichloropropane	63	65,114
1,2-Dichlorotrifluoroethene	67	117
1,2-Difluorotetrachloroethene	101	103, 167
1,3,5-Trimethylbenzene	105	120
1,3-Dichlorobenzene	146	148, 111
1,4-Dichlorobenzene	146	148, 111
1,4-Dioxane	88	58
1-Chloropropane	63	78
1-Propene	41	42
2,2-Dichloropropane	77	97

TABLE 7
Characteristic Ions of Volatile Organic Compounds

2,4,4-trimethyl-1-pentene	41	57, 97
2-Butanone	72	57
2-Chloroethyl vinyl ether	63	65, 106
2-Chloropropane	78	63
2-Chlorotoluene	91	126
2-Chloro-1,3-butadiene	88	53
2-Hexanone	43	58,100
2-Nitropropane	39	42, 44
2-Octane	43	58
2-Octanol	45	55
4-Chlorotoluene	91	126
4-Methyl-2-Pentanone	43	58,100
Methacrylonitrile	67	41
Acetone	43	58
Acetonitrile	39	40, 41
Acrolein	56	55
Acrylonitrile	53	52
Allyl Alcohol	57	40, 39
Allyl Chloride	76	41
Amyl Acetate	43	70, 61
Benzene	78	--
Benzyl Chloride	91	126, 65
Bromobenzene	156	77, 158
Bromochloromethane	129	49, 130
Bromodichloromethane	83	85
Bromoform	173	171,175,
Bromomethane	94	96
Butyl Acetate	73	56, 43
Butyl Acrylate	73	56, 55
Butyl methacrylate	87	69
Camphene	93	121
Camphor	95	81
Carbon disulfide	76	78
Carbon tetrachloride	117	119,121
Chlorobenzene	112	114
Chloroethane	64	66
Chloroform	83	85
Chloromethane	50	52
Chlortrifluoroethene	116	118
cis-1,3-Dichloropropene	75	77
Cyclohexane	56	84, 69
Cyclopentene	67	68, 68, 53

TABLE 7
Characteristic Ions of Volatile Organic Compounds

Dibromochloromethane	129	208,206
Dibromomethane	93	95, 174
Dichlorodifluoromethane	85	87
Dimethylnaphthalene (total)	141	156, 155
Epichlorohydrin	57	62, 49
Ethanol	46	45
Ethyl Acetate	70	61, 43
Ethyl Acrylate	55	56
Ethyl Ether	59	74, 75
Ethylbenzene	106	91,
Ethyl methacrylate	69	41, 99
Freon TF	101	103, 151, 85
Hexachlorobutadiene	225	223
Hexane	56	57, 86
Indan	117	118, 58
Iodomethane (methyl iodide)	142	127
Isobutyl Alcohol (Isobutanol)	43	41, 42
Isoprene	67	53, 59
Isopropanol	45	59
Isopropyl Acetate	43	61, 87
Isopropyl Ether (DIPE)	45	87
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Methylene chloride	84	49,51,86
Methylnaphthalene (total)	142	141, 115
Naphthalene	12	--
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n-Butylbenzene	91	92, 134
n-Heptane	57	43, 71
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n-Propylbenzene	91	120
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Propyl Acetate	43	61, 73
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Styrene	104	78,103
Tert-Amyl Methyl Ether	73	55, 87
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Tert-Butyl Ethyl Ether	59	87
Tert-Butylbenzene	119	91, 134
Tetrachloroethene	164	129,131,166
Tetrahydrofuran	42	72, 71
Toluene	92	91
Total Xylenes	106	91
trans,-1,3-Dichloropropene	75	77
Trans-1,4-dichloro-2-butene	53	75
Trichloroethene	130	95,97,132
Trichlororfluoromethane	101	103
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Dichlorofluoromethane	67	69
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1,2-Dichlorotrifluoroethane	67	117
Vinyl chloride	62	64
4-Bromofluorobenzene (sur)	95	174,176
1,2-Dichloroethane-d4 (sur)	65	102, 104
Toluene-d8 (sur)	98	70,100
Fluorobenzene (istd)	96	77
Chlorobenzene-d5 (istd)	117	82,119
1,4-Dichlorobenzene-d4 (istd)	152	115,150

Company Confidential & Proprietary

ATTACHMENT E

EUROFINS

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Title Page

Environmental Quality Policy Manual

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(as documented on page 1)

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Revision Log

Revision: 14	Effective Date: This version

Revision: 14	Effective Date: This version	
Section	**Justification**	**Changes**
Revision Log	Formatting requirement per 1-P-QM -QMA-9017356	Removed revision logs up to the previous version
Throughout document	Title change	Update QA Manager references to be QA Director
Throughout document	Clarification	General rewording for better clarity and flow of information
Section 1.3	Reflect current version	Revised mission statement
Section 1.4	Enhancement	Revised display of information
Section 2.4	Additional scope of document	Added service centers associated with Lancaster to the scope of this document
Section 2.6	Process change	Remove reference to quarterly reports as this information is communicated to management through different means
Section 2.11.1	Process change	Added "Note" regarding training for seasonal and temporary staff
Section 2.16	Unnecessary statement	Removed reference to Eurofins sister laboratories
Section 2.17	Clarification/Process change	Clarified that the Ethics Statement is signed annually Changed Ethics Committee to Ethics hotline service
Section 3.1	Changes to campus	Updated description of campus to reflect current state
Section 3.3	Clarification	Added IT systems to the areas addressed by disaster recovery
Section 3.4	Added information	Clarified actions taken if there are adverse environmental conditions in the facility
Section 4.2	Clarification	Added explanation for applying signatures electronically to document through the document control interface
Section 5.1	Added information	Revised to include information on the bottle lot checks
Sections 5.4 & 5.5	Enhancement	Added explanations of the bar code reading process used in sample tracking and the individual bottle code tracking
Sections 5.4, 6.1 & 6.3	Added information	Specified that samples and standards/reagents are stored separately.
Section 6.3	Updated requirement	Added information regarding the need for ISO Guide 34 and ISO 17025 approved materials.
Section 6.4.4	Clarification	Added notation for reporting noncompliant data when approved by the client and comments added to the report.
Section 6.5.1.2	Added information	Specified that passwords must adhere to the Eurofins Password Policy and must be "strong: passwords
Section 6.5.2	Enhancements	Added information on the software change request, periodic reviews and retirement documents. Generalized the explanation on validation plans.
Section 8.1	Reflects current process	Changed the listing of services to current offerings and updated the website link for certification
Section 10.1	Enhancement	Added Bottle orders and clarified to reflect current flow
Section 11.1	Clarification	Added ability of QA to stop work for critical internal audit issues
Section 11.2	Process change	Added electronic means of routing documents; removed quarterly report reference
Section 11.5	Unnecessary statement	Removed the need to stamp documents as confidential

Revision: 14	**Effective Date:** This version	
Section 12.1	Clarification	Explanations added regarding actions for noncompliant QC data; removed quarterly report reference
Section 12.2	Updated process	Information on the ICAR process was revised to reflect the current practice using Jira
Section 12.3	Clarification	Added information regarding QA trend evaluation of client concerns and routing of the client satisfaction survey
Section 12.4	Process change	Revised to remove references to the Ethics Committee and add information on the Ethics Hotline service; removed quarterly report reference
Section 12.4	Enhancement	Added information about use of Project Cycle to proactively ensure meeting the needs of the client
Section 13.4	Process change	Removed reference to subcontract warranty statement and added Laboratory Analytical Services Subcontract form
Appendices A-F and J-I	Updated for current information	Updated to reflect current SOPs, personnel, methods, etc.

Revision: 13	**Effective Date:** Aug 8, 2014	
Section	**Justification**	**Changes**
Revision Log	Formatting requirement per 1-P-QM-QMA-9017356	Removed revision logs up to the previous version
Throughout Document	Reflect re-identification of documents in EtQ	Replaced all prior Level 1, 2, 3, and 4 document numbers (analyses excluded) with EDR numbers
Title Page	Regulatory compliance	Added text for address, phone, reviewer/approver titles (previously listed on hardcopy covers and pre-EtQ versions)
Section 1	Updated training requirements	Removed requirement for all employees to read the appendices, they are available as resources; required for dept. 4052 only.
Section 1.2	Regulatory compliance	Inserted additional ISO17025 text at opening and closing of Quality Policy Statement
Section 2.1.1	New Section	Summarize processes to ensure business continuity and contingency plans
Section 2.2	Reflect current structure	Moved summation of technical director and QA manager to this section; changed employee responsible for daily operation from COB to VP. Throughout document, clarified management structure to include VP.
Section 2.6	Added process	Added ability for management and/or QA to issue a stop work notice.
Section 2.16	Regulatory compliance	Inserted additional ISO17025 text regarding ensuring impartiality, operation integrity, etc.
Section 3	Added building	Added building D
Section 4.2	Clarification	Noted that interim amendments to controlled procedures are not allowed.
Section 5.5	Added information	Noted that minimum sample retention period is 2 weeks form reporting
Section 6.4	Clarification	Standardized use or the terminology for equipment (supporting units) vs instruments (data producing units)

Revision: 13	Effective Date: Aug 8, 2014	
Section 6.5.1.9	New section	Added to address passwords and audit trails for systems used to process electronic data
Section 6.5.2	Clarification	Clarified SDLC processes
Section 8.1	Added information	Added reference to laboratory website for all current accreditation records
Section 10.2	Added information	Added information regarding electronic data, signatures, and audit trails
Section 10.4	Regulatory compliance	Added DoD reporting requirements for DL, LOD, LOQ
Section 10.5	Clarification	Clarified process and intent of data review
Section 10.7	Updated process	Added process for identification of accreditation status Noted use of LlabWeb for secure data transfer
Section 12.1	Added process	Added ability for management and/or QA to issue a stop work notice.
Section 12.4	Clarification, new process	Clarified processes that address preventive action; changed "PPI" to "Lean"
Section 13.2	Clarification	Added detail on project evaluations
13.4	Added detail	Added information regarding the subcontractor warranty and the need to ensure subcontractor can meet accreditation requirements
Appendices A-J	Updated for current information	Updated to reflect current SOPs, personnel, methods, etc.

1. INTRODUCTION

This *Quality Policy Manual* is based upon Eurofins Lancaster Laboratories Environmental LLC's (herein referred to as the laboratory) overall business and management philosophies, mission, and goals. This manual is written to present the policies employed by the laboratory as well as the support departments that serve the environmental laboratories and to comply with the requirements of the National Environmental Laboratory Accreditation Program, ISO 17025, and the Department of Defense (DoD). These policies define the "what" we do with emphasis on management's responsibilities and commitment to quality. Governing SOPs are in place within the organization, to ensure the proper execution of this policy document (refer to Appendix A). This manual is required reading for laboratory personnel. The appendices are available resources to all personnel but are not required reading for all employees. The most recent and up-to-date *Quality Policy Manual* and all referenced documents are available to all laboratory personnel who work in or support the laboratory. The laboratory actively strives for continuous improvement of its quality systems to better serve our clients.

1.1 Mission Statement

The laboratory offers analytical and consulting services in the chemical and biological sciences with comprehensive expertise in environmental laboratory applications. The company mission statement describes the corporate philosophy:

At Eurofins Lancaster Laboratories, Environmental LLC we are people working together to serve the health and environmental needs of society through science and technology. We strive to be the recognized leader in all that we do.

Our mission is to provide independent laboratory services in the chemical and biological sciences with excellent quality and service. As a corporate community, we:

- Deliver quality by fully understanding and always meeting the requirements of those we serve.

- Live our values by relating to our clients, coworkers, shareholders, suppliers, and community in a fair and ethical manner.

- Manage our growth and financial resources so we can serve our clients well, provide a satisfactory return to shareholders, and maintain our meaningful and enriching workplace.

1.2 Quality Policy

The Executive Management Group recognizes quality as a key element of the laboratory's standard of service. The group supports the laboratory's commitment to quality as defined by NELAP, ISO 17025, DoD, and other regulatory agencies (i.e. states) through the strict adherence to the Quality Policy Statement. The Quality Assurance Director wrote the Quality Policy Statement, with final approval from the laboratory Vice-President. The policy cannot be revised without their approval.

The Quality Policy Statement gives employees clear requirements for the production of analytical data. Employees are trained on the components of the Quality Policy Statement during their first day of orientation. Each employee signs the statement upon hire as agreement to implement the policy in all aspects of their work. Employee agreement to any subsequent revisions of the statement is obtained by documented reading and understanding of an agreement to follow the Quality Manual, which contains the current version of the statement. The statement is as follows:

As an organization, all personnel are committed to high quality professional practice, testing and data, and service to our clients.

We strive to provide the highest quality data achievable by:

- Following all documentation requirements; describing clearly and accurately all activities performed; documenting "real time" as the task is carried out; understanding that it is never acceptable to "back date" entries and should additional information be required at a later date, the actual date and by whom the notation is made must be documented.

- Providing accountability and traceability for each sample analyzed through proper sample handling, labeling, preparation, instrument calibration/qualification, analysis, and reporting; establishing an audit trail that identifies date, time, analyst, instrument used, instrument conditions, quality control samples (where appropriate and/or required by the method), and associated standard material.

- Emphasizing a total quality management process and commitment to continuous improvement which provides accuracy, and strict compliance with agency regulations and client requirements, giving the highest degree of confidence; understanding that meeting the requirements of the next employee in the work flow process is just as important as meeting the needs of the external client.

- Providing thorough documentation and explanation to qualify reported data that may not meet all requirements and specifications, but is still of use to the client; understanding this occurs only after discussion with the client on the data limitations and acceptability of this approach.

- Responding immediately to indications of questionable data, out-of-specification occurrences, equipment malfunctions, and other types of laboratory problems, with investigation and applicable corrective action; documenting these activities completely, including the reasons for the decisions made.

- Providing a work environment that ensures accessibility to all levels of management and encourages questions and expression of concern on quality issues to management.

We each take personal responsibility to provide this quality product while meeting the company's high standards of integrity and ethics, understanding that improprieties, such as failure to conduct the required test, manipulation of test procedures or data, or inaccurate documentation will not be tolerated. Intentional misrepresentation of the activities performed is considered fraud and is grounds for termination.

I understand the expectations and commit to implementation of all applicable policies and procedures and to providing quality data.

1.3 Statement of Values

Eurofins Lancaster Laboratories Environmental is a team of people who work together to serve the health and environmental needs of society through science and technology.

At Eurofins Lancaster Laboratories Environmental, our mission is to provide independent laboratory services in the chemical and biological sciences with excellent quality and service. We fulfill our mission by incorporating our values into our work every day.

As a corporate community, we embrace our heritage of integrity and strive to live by the following principles:

- Fairness and honesty in all our relationships
- Mutual trust
- A respect for ourselves and others
- A sense of caring that leads us to act responsibly toward each other and society, now and in the future
- Loyalty to our clients and one another
- A spirit of open-mindedness as we deal with all
- Dedication to service
- Good stewardship of our resources
- A commitment to flexibility and continuous improvement

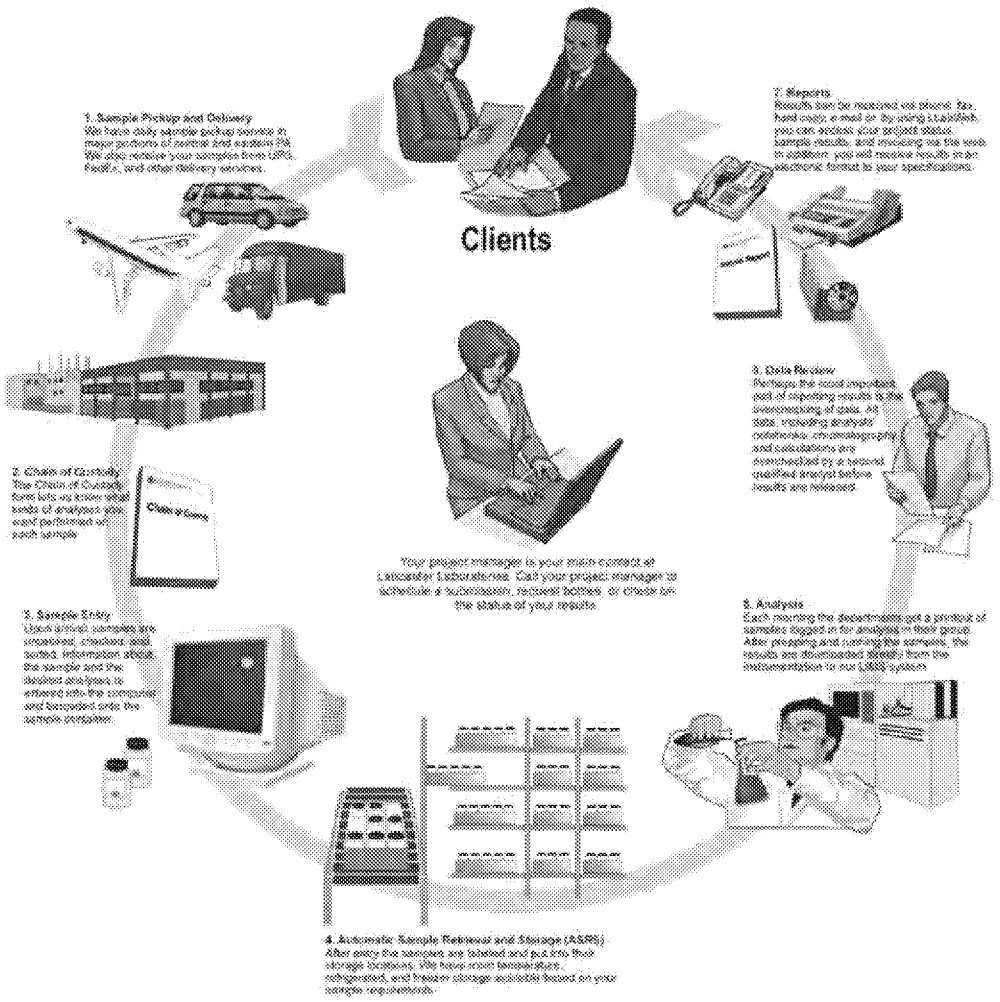
We are committed to:

- Delivering quality by fully understanding and always meeting the requirements of those we serve.
- Living our values by relating to our clients, coworkers, shareholders, suppliers and community in a fair and ethical manner.

- Managing our growth and financial resources so we can serve our clients well, provide a satisfactory return to shareholders and maintain our meaningful and enriching workplace.

At Eurofins Lancaster Laboratories Environmental, we each take personal responsibility to live these values in all of our dealings, knowing full well that our pledge may involve difficult choices, hard work and courage.

1.4 Sample Flow-Through Diagram



Certifications, Accreditations, and Registrations

Accreditation/Certification is the process by which an agency or organization evaluates and recognizes a laboratory as meeting certain predetermined qualifications and/or standards. It is the one generally accepted method by which a laboratory such as ours can demonstrate its capability of generating acceptable, professional, quality test results in those areas in which it claims competence. To this end, we have actively sought accreditation by organizations offering it in those areas relevant to our technical expertise. We strive to ensure that the facilities, equipment, procedures, records, and methods used by the laboratory in the testing of environmental samples are in compliance with the requirements of these standards.

Although organizations offering accreditation differ somewhat in the details of their programs, they generally evaluate laboratories in four basic areas: personnel (adequate staffing, education, training, and experience), physical facilities, instrumentation/equipment, and quality assurance program. This evaluation is performed by one or more of the following procedures: periodic on-site inspections of the laboratory by assessors experienced in technical operations, quality systems, and management; periodic analysis of proficiency test samples; and periodic updating of the laboratory's file to reflect changes in personnel, equipment, or services offered. Some states offer reciprocity with other state programs.

Appendix B lists accreditations and registrations held by the laboratory in support of environmental work. Current copies of all scopes of accreditation are available on the laboratory website and are kept on file in the Quality Assurance Department.

2.0 ORGANIZATION AND PERSONNEL

2.1 Company Overview and History

The laboratory was founded in 1961 by Dr. Earl Hess in response to a need for high quality technical services by the agricultural and industrial communities in southeastern Pennsylvania. Nourished in a culture of quality and caring about all those associated with the business, the corporation became an industry leader known for innovative business practices and people-friendly policies. The company was independently owned until the retirement of Dr. Hess in 1995. At that time, the laboratory was acquired by a publicly held company, Thermo TerraTech, Inc., a Thermo Electron company. Ownership changed in September 2000, when the laboratory was acquired by Goldner, Hawn, Johnson, and Morrison, Inc. (GHJ&M), a private equity investment firm. In August 2005, the laboratory was acquired by Fisher Scientific under their BioPharma Division. On November 9, 2006, Thermo Electron and Fisher Scientific merged to form Thermo Fisher Scientific. In April 2011, Thermo Fisher Scientific sold the laboratory to Eurofins Scientific. Effective July 1, 2013, the Pharmaceutical and Environmental Divisions were split into separate business entities and the company name became Eurofins Lancaster Laboratories Environmental, LLC. The laboratory continues to operate as an independent laboratory and is incorporated by the State of Delaware.

The laboratory provides a wide array of laboratory services to clients working in environmental industries. We strive to offer high quality technical services in the chemical and biological sciences with personal attention to client needs. These services include chemical analyses, microbiological testing, and analytical method development. We are, therefore, a technical service company and do not manufacturer or distribute goods. Our "product" is accurate and timely technical information and our continued existence depends on the quality of the services we offer and efficiency with which we deliver them.

2.1.1 Business Continuity and Contigency Plans

Various policies and practices are in place to address continuity of business and contingency plans to ensure continued operations or minimal disruption in operations should unplanned events (natural disasters, unexpected management changes, etc.) occur.

Section 2.2 of this document explains the identification of deputies for key management positions. Section 3.3 discusses the disaster recovery plan. Section 6.5 addresses the security and backup of our computer systems. Section 10.8 addresses handling of client records should the company have a change in ownership or go out of business.

2.2 Organizational Structure

The laboratory Vice-President/Technical Director, Duane Luckenbill, is responsible for the daily operations of the laboratory.

The Executive Management Group is defined as the Eurofins Environment Testing US Chairman of the Board and President and Eurofins Lancaster Laboratories Environmental, LLC Vice-President.

The management staff includes directors, managers and group leaders. Organizational charts are presented in Appendix C. A list of key personnel is also provided. The Vice-President and Quality Assurance (QA) Director have identified deputies for all key management personnel.

2.2.1 Technical Director

The Technical Director ensures that the laboratory's policies and objectives for quality of testing services are documented in this quality manual. The Technical Director must assure that the manual is communicated to, understood, and implemented by all personnel concerned.

2.2.2 Quality Assurance Director

The Quality Assurance Director ensures that the quality system is followed at all times. The QA Director reports directly to the Vice-President thus ensuring corrective actions to quality issues are taken promptly and are separate from business decisions. The QA Director has no direct supervisory responsibility for the generation of technical data to avoid any conflict of interest in administrating the QA program. The QA Director has the final authority to stop work that compromises our integrity or data quality. The situation must be investigated and appropriate corrective action must be put in place before the QA Director will authorize the resumption of work. The specific duties of the QA Director are communicated in job plan format.

2.3 Management Responsibilities

Laboratory management duties are outlined for supervisory personnel using a job plan format, which details each individual's responsibilities along with expected results. Typically, management duties include, but are not limited to:

- Personnel hiring and training
- Supervision of personnel
- Providing resources to ensure a work environment free from commercial, financial, and other undue pressures that may adversely affect the quality of their work
- Providing resources to ensure a safe work environment
- Directing daily work operations, including scheduling of work
- Ensuring compliance with the TNI Standards, ISO 17025, Department of Defense Quality Systems Manual, state agency programs, analytical methods, and client requirements.
- Assessing laboratory capacity and workload
- Resource allocation
- Ensuring quality of data produced

- Contributing to the continuous improvement of the laboratory operation
- Ensuring that corrective actions are carried out in an appropriate and agreed upon time-frame.
- Communicating problems and concerns to Senior and Executive Management to enlist a higher level of support for corrections and continuous improvements.
- Maintaining awareness of technical developments and regulatory requirements

2.4 Overview of the Quality Assurance Program

Quality Assurance (QA) is responsible for developing planned activities whose purpose is to provide assurance to all levels of management that a quality program is in place within the laboratory, and that it is functioning in an effective manner that is consistent with the requirements of NELAP, ISO 17025, DoD, and any other regulatory agencies (i.e. states) in which we hold accreditation. Although the laboratory is a wholly owned subsidiary of Eurofins Scientific, the Quality Assurance and Quality Systems operations described in this manual are specific to the Lancaster site and associated service centers.

The administration of the QA program is the responsibility of the QA Director in cooperation with all levels of management.

The QA program, as directed by executive management, was established to:

- Ensure accountability, accuracy, and traceability of all analytical data generated.
- Ensure that current regulatory, agency, and client requirements are being met.
- Ensure that operating procedures are in place to minimize the possible loss, damage, and tampering with data, in addition to ensuring that raw data is stored in a secured area and is maintained by designated archivists and/or system administrators.
- Ensure that curriculum vitae (CVs) and training records are maintained to document that staff members have the necessary education, training, and experience to perform their job responsibilities and functions.
- Ensure that regulatory training is provided to applicable employees on a routine and ongoing basis.
- Ensure that all procedures are available, controlled, and current.
- Ensure that documentation demonstrates that procedures are carried out in a compliant and effective manner.
- Ensure that all equipment and instrumentation is qualified, maintained, and calibrated, as appropriate, in accordance with written standard operating procedures.
- Ensure that all significant laboratory problems are investigated, evaluated for root cause and corrective action is put in place as documented
- Ensure that an internal audit program is in place to provide on-going monitoring and confirm that laboratory personnel are adhering to standard operating procedures and applicable regulations.

- Ensure that quality issues are brought to the attention of management in a timely manner.

2.5 Quality Assurance Responsibilities

The QA Director assigns tasks with input from the company Vice President. The primary responsibilities of QA include, but are not limited to the following:

- Oversee the laboratories' internal audit program which consists of various audit types and applies to all laboratory activities (technical and administrative).

- Review and approve standard operating procedures and analytical methods.

- Review and approve validation documentation.

- Review non-conforming quality control data

- Perform tracking and trending of quality measurements and report the status and effectiveness of the quality system to management.

- Approve investigation and corrective action reports (ICARs) and audit responses to ensure that they are completed in a timely manner, evaluated for root cause, that corrective actions are implemented as needed and to monitor corrective action for effectiveness.

- Host client and regulatory agencies during facility audits and follow-up to any cited deficiencies.

- Provide regulatory guidance to the laboratory and support areas.

- Monitor Good Laboratory Practice (GLP) regulatory activities.

- Communicate quality issues to management in a timely manner

- Provide and/or coordinate on-going regulatory training (e.g., GLP).

- Participate in the vendor and supplier approval process, including subcontractors.

- Review analytical data for compliance with our procedures.

- Prepare and review QA project plans (QAPPs) as required by EPA and client projects.

- Maintain and update this *Quality Policy Manual*.

- Maintenance of the Laboratory's accreditations, including but not limited to, administration of the proficiency test sample programs, both single and double blinds.

- Communicate (within 30 days) to the relevant state authorities when there are management or facility changes that impact the laboratory. Changes in the technical director must be communicated within 20 days.

2.6 Communication of Quality Issues to Management

The QA Department is responsible for preparing reports to Management to keep them apprised of outstanding quality issues. Reports to management foster communication, review, and refinement of QA activities to ensure that the QA program is adequate to meet regulatory and the laboratory's quality objectives. The following reports are used to communicate quality issues and include, but are not limited to:

- Internal, client, and agency audit reports and corrective action plans
- Proficiency test reports
- Investigation and corrective action reports
- Monthly quality status reports
- Plans for corrective action

Upon review of quality issues, management and/or QA may issue a stop work notice if an issue indicates the potential for a problem on a broader scale with an analysis. The investigation would need to be completed and the issue resolved before work could continue. The information is tracked through our Investigation and Corrective Action Report (ICAR) process.

2.7 Personnel Qualifications and Responsibilities

Full resumes and responsibilities of key personnel are provided in Appendix D.

Due to the number of analysts on staff, entry level chemists, technicians, and support personnel are not included in the resume section. However, all employees have job plans that define their responsibilities. Duties for these personnel typically include:

- Sample storage
- Sample preparations
- Performance of tests
- Calibration, operation, and maintenance of instruments
- Data entry
- Standard and reagent preparation
- Glassware preparation
- Data deliverables preparation

2.8 Relationship of Functional Groups and Quality Assurance Program

In addition to this *Quality Policy Manual*, aspects of the QA program are documented in a series of standard operating procedures that support the proper execution of this document. Technical operation procedures with required quality components are also in place. A list of the titles of relevant SOPs is provided in Appendix E. There are a variety of mechanisms used to communicate requirements and verify compliance with the QA program, including:

- Management requires that all employees read and be trained in the policies and SOPs that are pertinent to their jobs.

- Employee job plans define individual responsibilities. All job plans include QA aspects, and performance is reviewed annually.

- Laboratory audit findings are circulated to management and require a response and follow-up to items needing corrective action.

- Cross-functional meetings, including representatives from QA, Client Services, Marketing, management, and technical operations are held regularly to review specific projects and quality issues.

2.9 Balancing Laboratory Capacity and Workload

Evaluating laboratory capacity to perform specific projects is the responsibility of the Vice-President, laboratory directors and managers, and the Client Services director and manager. These responsibilities are documented in the individual job plans for these positions.

The laboratory facilities and staff size are very large compared to other laboratories serving the environmental industry. Many analysts are cross-trained to perform a variety of tests, and there is redundant equipment available in case of malfunctions. This minimizes the need to evaluate small and medium size projects against capacity available to complete them. Large projects are reviewed against capacity estimates before bids are submitted to ensure that the client's analysis schedule is met.

Regularly scheduled meetings are held with upper management, laboratory middle management, Client Services and QA personnel to review progress with current projects, as well as special requirements of new work scheduled for the laboratory.

Laboratory capacity and backlog is tracked on a continuous basis using information from the Laboratory Sample Information System (LIMS) including turnaround time, and work in-house.

2.10 Identification of Approved Signatories

All data is reviewed and verified prior to release to the client. Based on complexity or regulatory needs, some projects are designated for secondary (technical and/or QA) review of the Analysis Reports and/or data deliverables. Approved signatories for these secondary reviews are defined in the SOP on Data Entry, Verification, and Reporting. Directors, managers, group leaders, and other designated employees (such as QA, project managers, and senior technical staff) are designated to approve/release Analysis Reports. Request for approval of an employee to approve/release reports must be made through the QA Department. These authorized personnel are designated with an asterisk in the personnel list provided in Appendix C.

2.11 Personnel Training

The experience and training received by personnel is of great importance to our clients and regulatory agencies. Curricula Vitae (CVs) and on-going training documentation are available to demonstrate how personnel have been

prepared for the tasks they routinely perform. To ensure the highest quality of services at the laboratory, training programs and plans are developed to match skills with job functions. Accurate training documentation is the responsibility of both the employee and their supervisor. On a routine basis, the supervisor reviews and approves training documentation to verify that it is complete and current.

Training requirements can be met through education, prior job experience, internal and external training classes, on-the-job training, TRN training modules, procedure reading, or any combination thereof, to enable the person to perform assigned job functions and meet regulatory compliance.

Each analyst training to perform a new analysis is required to perform an initial demonstration of capability and meet the requirements for accuracy and precision before working independently on the test method. Typically, this is accomplished by the successful analysis of four known samples. However, there are certain tests performed that are not required by the mandated test method or regulation to perform the above procedure (i.e., EPA 1010, 9095). In this case, the analyst's documentation of proficiency is satisfied by the sign-off of having read, understood, and agreed to follow the SOP as written, on-the-job training and observation by a senior analyst.

Management personnel are responsible for planning ongoing professional growth and development activities for an employee through on-the–job training and/or internal and external training courses so an employee can maintain a current skill set to match job responsibilities.

An annual performance review based on job accountabilities, objective measures, and pre–defined standards is completed by management personnel for each employee. This assessment is documented and maintained. Input is obtained from other managerial personnel as needed.

2.11.1 New Hire Training

New employees are oriented as part of a year–long process that is designed to make the employee feel welcome and comfortable by defining our culture, traditions, philosophies, and work practices. During the orientation process an employee learns about personnel and safety policies and business strategies in addition to quality, ethics, and customer satisfaction expectations through a formal process administered by our Human Resources Department.

New employees are required to attend "core" technical orientation, as applicable, which can entail the participation in training module exercises, short session attendance, and/or other skill training specific to their assigned department or job function. Additional job-specific training required for an employee is based upon their assigned duties and is identified by their supervisor. Technical orientation occurs during the first few weeks of employment.

Note: Seasonal and temporary employees have reduced "core" training requirements based on the assigned tasks and as defined by QA, Safety, and the assigned department management.

The orientation process is designed to enable employees to initiate and take responsibility for their personal and professional career growth at the laboratory. The orientation process is conducted without regard to employee race, color, creed, national origin, sex, age, or disability in accordance with the laboratory's Employee Equal Opportunity (EEO) policy.

2.11.2 Ongoing Training

Refresher and ongoing training occurs through various means, which include but are not limited to, training in or independently review new/updated standard operating procedures and TRN training procedures; on-going regulatory training; in-house or off-site classes or seminars. The goal of this training is to ensure that employees

remain current with changes to laboratory systems and practices, as applicable to their job function. Retraining and re-qualification activities occur as directed by procedures or regulations. Employees are retrained if an issue or investigation warrants that retraining is a necessary corrective action. Management directs when employee re-training is required, and the extent of the re-training.

2.12 Regulatory Training

The QA Department is responsible for coordinating and conducting initial and ongoing regulatory training (i.e., GLP) for all applicable laboratory and support personnel. It is the responsibility of management within each department to ensure that personnel attend the required training sessions.

The choice of training format and topics covered for ongoing regulatory training is left to the discretion of QA and the trainer. All training sessions reinforce the concepts in the regulations as they are relevant to the laboratory.

Whenever possible, after training is completed, a demonstration of proficiency of the training topic is given. The demonstration of proficiency is generally in the form of a quiz although other demonstrations of proficiency are acceptable depending on the scope and content of the training. If necessary, training is presented and/or repeated one-on-one with individuals who do not demonstrate proficiency in the training topic. This is performed by QA in conjunction with applicable laboratory management personnel.

2.13 Employee Safety

The laboratory, being mindful of its responsibilities as an employer and active corporate citizen, has established the following objectives of its safety program:

- Provide a safe environment for its employees, visitors, and the community surrounding its place of business.
- Provide ongoing safety training for employees.
- Provide all necessary facilities and equipment to ensure the safety of its employees and to minimize all chemical exposure during the normal performance of their required tasks, and to take all necessary precautions to safeguard the surrounding environment.
- Provide periodic health physicals for employees.
- Foster and encourage safe operations and a proper safety attitude on the part of our employees through general operations and systems, training, and the *Chemical Hygiene Plan* (CHP).

The CHP addresses various aspects of our safety program in greater detail.

A Safety Committee works to enhance our overall safety program. The committee meets on a routine and ongoing basis and its specific responsibilities are detailed below:

- Review accident and incident reports. Make recommendations for methods of prevention to eliminate further accidents.
- Promote safety awareness and distribute safety information by various means (e.g., posters, videotapes, pamphlets, and books). Use internal communication channels to promote safety awareness.
- Enhance and recommend safety-training programs for all employees, as necessary.

- Maintain up-to-date information on employee concerns that are safety related. Offer input and information to the Chemical Hygiene Officer and/or Safety Officer, as needed.

2.134 Client Services/Project Management Responsibilities

Members of the laboratory Client Services/Project Management Group are responsible for organizing and managing client projects. Clients are assigned a project manager (a.k.a. "CSR") who serves as their primary contact at the laboratory. It is the project manager's responsibility to act as the client advocate by communicating client requirements to laboratory personnel and ensuring that clients provide complete information needed by the laboratory to meet those requirements. All client verbal communications are documented by the project manager in a controlled notebook. In addition to information management, Project Management responsibilities include:

- Coordinating and preparing proposals in conjunction with technical staff.
- Confirming certification status.
- Hosting client visits and audits.
- Coordinating and communicating turnaround time (TAT) requirements for high priority samples/projects.
- Answering common technical questions, facilitating problem resolution.
- Providing clients with sample status report or results (partial reports) prior to receipt of the final Analysis Reports (e.g., fax, e-mail, phone).
- Scheduling sample submissions, sample containers, and sample pick-up via the laboratory courier service.
- Informing the client of deviation from their contract.

2.15 Confidentiality

Strict confidentiality is maintained in all of our dealings with clients. Confidentiality agreements, therefore, are willingly provided.

All employees are required to protect company technical data, including client names and test results from disclosure to any third party. This policy, as described in the *Eurofins Lancaster Laboratories Employee Handbook*, is provided and presented to employees during their orientation period and whenever revisions are made.

Intellectual property associated with the testing that we perform under contract for a client is the property of the client.

In an attempt to ensure the confidentiality of our systems and procedures within our laboratory, it is our policy to restrict the distribution of our internal procedures to clients. Clients are permitted to review our procedures while on-site as part of an audit or visit. Based on this policy, we would request that any documents viewed would not be shared or made available to any third parties without the permission of the laboratory.

2.16 Business Conduct

Our business conduct policy applies to all operations of the company. All employees must avoid involvement in any activities that would diminish confidence in their competence, impartiality, judgment, or operational integrity. All employees must further avoid any relationship with other individuals or organizations that might impair, or even appear to impair, the proper performance of their company-related responsibilities. Employees must avoid any situation that might affect their independence of judgment with respect to any business dealings between the company and any other organization or individual. Any employee who believes that they have such a conflict, whether actual or potential, or who is aware of any conflict involving any other employee must report all pertinent details to the Vice-President or President of the company. The company's management vigorously enforces this policy and takes prompt and appropriate action, including termination, against any employee found to be in violation.

2.17 Operational Integrity

All employees review and sign the Employee Ethics Statement on their first day of employment and annually thereafter. Employees responsible for generating, handling, or reviewing laboratory data understand that the laboratory mission is to perform all work with the highest level of integrity. Under no circumstances are shortcuts or generating results to suit a client's purpose rather than good scientific practice considered acceptable. Any violation of the laboratory ethics policy results in a detailed investigation that could lead to termination.

All levels of management consider the following activities unacceptable:

- Knowingly recording inaccurate data.

- Fabrication of data without performing the work needed to generate the information. This includes creating any type of fictitious data or documentation.

- Time travel or adjusting clocks on computerized systems to make it appear that data was acquired at some time other than the actual time.

- Manipulation of data for the express purpose of passing system suitability or quality control criteria.

- Selective use of data generated, or not using data that was legitimately generated and has an impact on the outcome of the test.

- Executing significant deviations from approved test methods and procedures without prior approval from the laboratory management and/or the client.

If an issue does arise which could compromise data integrity, personnel are instructed to perform the following activities:

- Clearly document the situation and maintain all data generated. There is a big difference between poor judgment and fraud. Fraud usually involves intent to conceal an action taken. Therefore, the more documentation that is maintained, the less likely an action is considered fraudulent if further scrutinized.

- When out-of-specification results or quality type issues are detected, all supporting data and relative background information must be documented and presented for management review. Problem resolution and client contact, as applicable, must also be documented.

- Review any questionable situations and decisions with a supervisor.

- Bring a questionable or uncomfortable issue directly to the QA Director or a member of the QA Department as part of our QA open door policy.

- Utilize the company's anonymous Ethics hotline service. See Section 12.4 of this manual.

3 BUILDING AND FACILITIES

3.1 Facility

The laboratory is located at 2425 New Holland Pike, Lancaster PA. The facility consists of two campuses with multiple buildings located on the North and South sides of Route 23. The two campuses are connected by a pedestrian bridge that spans Route 23.

Building A resides on a commercial plot measuring 13.6 acres on the north side of Route 23. Building A is a three-story building of concrete and steel construction which houses both laboratory space and administrative offices. It is approximately 108,000 square feet and consists of approximately 47,000 square feet of laboratory space; 29,000 square feet of office space; and 32,000 square feet of storage, mechanical, and common areas. On this parcel, adjacent to Building A, sit two chemical storage buildings (Buildings I and L) with a total space of 2500 square feet. In addition, a 10,500 square foot storage building houses stability chambers (Building J). The bottles packing area, which includes preservation of bottles being sent to clients for sampling, is located in a separate 3100 square foot building (Building K). In addition, there are two other buildings (Buildings G and H) with a total square footage of 20,000 square feet that host recycling, storage, workshop and facilities maintenance areas.

The remaining buildings reside on a commercial plot measuring 35.7 acres on the south side of Route 23. These building are connected to the north campus buildings via a pedestrian walkway over the highway.

Building B is a three-story building of steel and concrete construction. It is approximately 56,000 square feet and consists of approximately 17,000 square feet of laboratory space; 14,000 square feet of office space; and 25,000 square feet of storage, mechanical, and common areas.

Building C resides between buildings B and D and consists of a three-story building of steel and concrete construction. It is approximately 47,000 square feet and consists of approximately 25,000 square feet of laboratory space; 6,900 square feet of office space; and 15,100 square feet of storage, mechanical, and common areas. The first floor houses the main lobby and visitor's entrance.

Building D is connected to building C. It is a 78,000 square foot, four-story building of steel and concrete construction and provides approximately 35,000 square feet of laboratory space, 19,000 square feet of office space, and 24,000 square feet of storage, mechanical, common area.

Two small support buildings (Buildings E and F) with a combined space of approximately 800 square feet are used for chemical and waste storage on the south campus.

The Lancaster campus also utilized an adjacent parcel for a technical training center. This space is approximately 6,500 square feet.

There is an automatic fire alarm and security system hooked up at the facility. This system is monitored offsite by Choice Security. The entire campus and all exterior doors are monitored by video surveillance.

This facility is serviced by public sewer. Drinking water comes from a private well while the facility sprinkler system is fed by the public water supply. The closest surface water is the Conestoga Creek.

3.2 Security

The laboratory is considered a secure facility. All outside doors except the main lobby entrance are locked during normal business hours to prevent unauthorized entry. An attendant monitors this entrance at all times.

During evenings, weekends, and holidays, all doors are locked and Security personnel are on site to prevent unauthorized entry into the building. Video cameras are utilized by Security personnel to monitor the facility grounds.

Every employee is issued a photo ID badge which also serves as a building access card. This badge must be worn at all times while on laboratory property so that employees are easily identified. Access to secured/designated areas within the building is limited to only applicable employees through the building security system. This system is administered by Security staff.

All visitors must register with the lobby attendant and are issued a visitor badge. A staff person must accompany visitors while in the facility. Additional visitor rules are outlined in the *Visitor Security and Safety Rules* pamphlet which is provided to all guests.

Building access cards are issued on a temporary basis to contractors or service technicians (e.g., electricians and plumbers) who need access to the building to work on a project. These cards provide the contractor with limited access during the normal workday and must be returned when the work is complete.

3.3 Disaster Recovery

A disaster recovery plan is in place to provide direction for situations where normal operations of the laboratory are not possible. In the event that the building or information technology (IT) systems would be severely challenged, a designated disaster recovery team, which includes Physical Services, Maintenance, Safety, Corporate Management, Public Relations, IT, QA and other applicable personnel depending on the scope of the disaster, would assemble at a designated area to assess the situation and formulate a plan.

The plan addresses, in general terms, how to approach the following issues: electrical failures, heating/air conditioning failures, fire/building evacuation, computer failures, hazardous material spills, injury to employees, pandemic flu, disruption of phone service, and stability chamber failures.

3.4 Environmental Monitoring

The air handling system for the main laboratory is specially designed to protect sensitive instruments from harmful vapors to ensure that samples are not contaminated. The Physical Services/Maintenance Group is responsible for maintaining the HVAC and exhaust hood systems. This is particularly important in our instrumentation rooms and computer center where a controlled environment, positive pressure system is maintained.

Most refrigerators, freezers, incubators, and ovens used for analysis are monitored by a computerized system equipped with stationary thermometer temperature probes linked to a master panel that is accessed through a computer. If a unit is outside of a predefined temperature range for a specified period of time, the system alarms. Units not on the computerized system must be monitored manually by recording thermometer temperature readings twice daily.

The laboratory is set up so that there is effective separation between neighboring areas in which there is potential for contamination. Laboratory storage blanks are also used to evaluate conditions under which samples for volatile

analysis are stored to monitor for cross-contamination potential. QA provides oversight of the environmental monitoring system.

QA and technical management, in consultation with facilities management as needed, evaluate any issues with environmental conditions that could have adverse effects on data to determine if alternative operational plans (moving testing to alternate laboratories, temporary shutdowns, etc.) need to be employed.

3.5 Water Systems

Well water and the public sewer system service the facility. The water system is monitored to meet the permit requirements of the Pennsylvania Department of Environmental Protection.

Reagent water is available to analysts for sample preparation (including dilution) and glassware cleaning. Two reverse-osmosis deionized water systems deliver highly purified water to a sealed fiberglass storage tank. From the storage tank the water is delivered to an ion-exchange-carbon filter system for further polishing. The water is also exposed to an in-line ultraviolet sterilization lamp before being circulated to taps throughout the laboratory.

Daily monitoring and preventive maintenance for the system is the responsibility of the Physical Services Department. Monthly and annual testing is performed as required by regulatory guidance. QA provides oversight of the water system monitoring. In addition, method blanks are tested with each batch (≤20) of samples.

3.6 Housekeeping/Cleaning

The laboratory is dedicated to providing a clean workplace. A third party professional cleaning service provides routine cleaning of “common areas” that include lavatories, drinking fountains, floors, and windows. Technical staff are responsible for the cleaning (or the contract of cleaning) of specific laboratory work areas.

Detergents used for cleaning contain no to very low levels of metals, pesticides/herbicides/ fungicides, or volatile solvents.

3.7 Insect & Rodent Control

Steps are taken to prevent, monitor, and control insect and rodent infestation. The coordination of this program is the responsibility of the Physical Services Department under the direction of QA. An outside service firm is contracted to perform routine and ongoing monitoring of the facility to ensure that preventive measures which are in place are effective and are working as intended.

No insect or rodent control chemical agents in a liquid or vapor form are applied or sprayed in any laboratory building, unless there is no other option, in which case department management must be contacted for approval.

3.8 Emergency Power Supply

The laboratory is located at the junction of two power grids that supply electrical service to the facility. If one of the power grids fails, we have the ability to work with the power company to have service switched to the other grid. Various types of diesel and natural gas generators are also available on a standby basis to supply power to selected areas of the laboratory in case of a power outage.

To reduce spikes and spurious line voltage changes to laboratory instruments that can affect results or damage electronic equipment, “conditional power” is fed to these sensitive instruments. All essential computer systems are

on uninterrupted power supply (UPS) which is a battery system that provides continuous conditional power for a limited time period in the event of a short power outage.

3.9 Facility Changes

Procedures are in place to manage change, ensure communication, and to minimize negative consequences through active participation of personnel involved in a facility change. The goal is to ensure that physical and environmental condition changes are adequately evaluated for impact and reduction of risk to quality, safety, health, employee, environment, property, analytical services, and business operations before and after the change is implemented.

4.0 DOCUMENT CONTROL

The administration of the document control system including tracking, filing, updating, and archiving of historical copies is the responsibility of the Office Services (OS) Department.

It is our policy to restrict the distribution of our internal procedures to clients and we discourage the distribution of company confidential documents outside of the facility. Clients are permitted to review our procedures while on-site as part of an audit or visit. Any documents that are distributed are only sent with the approval of QA.

The goals of the document control process are:

- Format documents according to consistent and defined standards
- Review and approve new documents
- Schedule review of existing documents
- Control of document versions and effective dates
- Review and approval of document changes
- Control document distribution and removal of obsolete documents
- Archive and protect obsolete documents

4.1 Hierarchy of Internal Operating Procedures

The hierarchy of controlled procedures at the laboratory is defined. These procedures and documentation are made available to promote consistency throughout the organization and to meet regulatory requirements. A list of relevant methods and procedures is located in Appendix E. The development of new procedures and the updating and reclassification of current procedures is an ongoing project.

4.1.1 Level 1 - Quality Policy Manual and Company Policies

The intent of these documents is to define “what” we do with emphasis on Executive and Management’s responsibility for quality.

The purpose of the *Quality Policy Manual* is to provide a framework to outline the quality systems at the laboratory. Organizational charts, list of SOPs, a list of equipment, instrumentation, and personnel resumes are included as attachments to this manual.

- Executive Management is responsible for ensuring that adequate personnel, resources, and support are available to carry out the requirements of this *Quality Policy Manual*.

- Management is responsible for ensuring that SOPs or other appropriate documents are written and available to personnel to define the practices and systems which support these policies.

- All employees are responsible for conducting business in a manner which is compliant with quality and company policies and associated SOPs or other appropriate documents. Review of these policies and procedures must be documented.

Additional company policies are written to support and expand upon this *Quality Policy Manual*. These policies contain more detailed information about a subject with approval signatures executed at the Executive and/or Management level.

4.1.2 Level 2 - Standard Operating Procedures

The intent of these standard operating procedures is to define "who, what, where, and when." These procedures provide specific information for a process or topic so that the requirements outlined in this *Quality Policy Manual* and company policies can be achieved. The review and approval of these SOPs is performed at the director/manager/group leader level, including QA review and signoff, and the responsibility of these SOPs lies with the area or person directing the operation.

SOPs can apply to site-wide operations, the entire company, across multiple departments, or a specific operating area.

4.1.3 Level 3 - Work Instructions (at a department level)

The intent of these procedures or documents is to define in greater detail the specific "how to". The level of detail in these documents must be sufficient so any appropriately trained person can perform the task accurately. Examples include, but are not limited to standard operating procedures (SOPs); maintenance and calibration procedures; and the laboratory analytical methods. Departmental level procedures/documents are reviewed and approved at the manager or group leader level including QA review and signoff.

4.1.4 Level 4 - Quality Records

The intent of these documents is to provide documented evidence to support our quality systems and operations. Examples include but are not limited to, data notebooks/logbooks, and preformatted data recording forms.

4.2 Document Approval, Issue, Control, and Maintenance

The document control process ensures that documents are approved and adequate for use. It ensures that documents are readily available to personnel and at locations where essential operations are performed.

Procedures are available in electronic form on the company's intranet site through our document management system. The Document Control Group maintains this system in a current and accurate state. These procedures can be printed from this system for reference by employees as the corresponding task is being performed. Prior to using a printed document, the employee must ensure that it is the current version.

Each procedure is uniquely identified and includes effective date, revision identification, and page numbering (total number of pages). All documents are searchable and uniquely identified in the document management system.

Controlled policies, procedures, and work instructions are reviewed and approved by appropriate individuals and are formally issued and administered through the Office Services Group. The review and approval signatures are applied as electronic signatures through the document control interface. Application of the signature is through secure log-in and password and can only be applied by those designated for the review or approval of the individual document.

Word versions of each procedure can be accessed within the document management system by designated personnel within the Document Control group. A PDF copy is maintained on a separate limited access server as a back up to the system.

Procedures undergo scheduled periodic review to ensure that they are accurate, current, and compliant. The frequency of review is either annual or biennial, depending on the procedure. QA is the final signature on procedures which gives QA the authority to implement the procedure; the exception is the Quality Assurance procedures for which the Vice President or his designee is the final signature. Upon the effective date of new or updated documents, all copies of obsolete documents are removed from service. The original historical copy of each outdated/obsolete procedure is clearly identified as a historical version and maintained in a permanent archive file separate from any current versions. (Note: OH EPA is required to review all revised documents applicable to its certification prior to the document being made effective).

Interim amendments to procedures are not allowed. Any needed changes require a revision to the document.

4.3 Client-Supplied Methods and Documentation

Client documentation to support environmental testing at the laboratory is maintained in a centralized area. This information is organized by client/project in the Client Services/Project Management Group. Client documentation includes the following information depending on project size and scope:

- Client supplied analyte lists
- Client supplied project plans
- Client contract quality manuals with specified limits, QC criteria, etc.
- Communication/correspondence records which relate to testing requirements, interpretation of results, or reporting formats

4.4 Laboratory Notebooks, Logbooks, and Forms

Procedures are in place to ensure that all data is traceable, authentic, complete, and retrievable. The following general requirements outline our system for the issuing, control, and archival of laboratory notebook and logbooks.

- The administration of notebooks and logbooks is controlled by the Office Services Group. They maintain a master index to uniquely number and identify each book distributed.
- Notebooks and logbooks can contain blank or preformatted pages.
- Notebooks and logbooks are bound, uniquely identified and have sequentially pre-numbered pages.

- If notebooks or logbooks contain preprinted laboratory form pages:
- A unique identification number is assigned to each form
- Forms are approved by appropriate management personnel before they are put into use
- Forms are reviewed on a routine basis to ensure they are still accurate and current
- Completed notebooks are returned to an archivist. Incomplete books are returned to Document Control:
- Two years from the issue date
- for employee specific notebooks – when the employee leaves the company
- for project specific notebooks – when the project for which it was used is complete
- In specific situations, records are bound to create books at the time of archival (e.g., temperature charts).
- At the time of archival any page(s) in the notebook or logbook that does not contain data documentation is crossed-out or a statement is written on the last page used to note that the book is complete to prevent data from being entered at a later date.
- Notebooks and logbooks identified as requiring permanent archival are assigned a designated qualifier.

4.5 Control of External Documents

Hard copy versions of external documents are controlled through the form system.

External documents such as copies of the 40 CFR and ASTM methods are stored exclusively in the QA Department. QA also keeps applicable agency documents on file, these include, but are not limited to, the TNI (The NELAC Institute) and ISO 17025 standards.

Environmental methods from the EPA or Standard Methods are available in the QA Department, but the technical areas also have copies that pertain to the tests that they perform. Any external document that is maintained in these areas must be inventoried and listed on a controlled form. Some methods are available on-line and are accessed through the Internet.

It is the laboratory's understanding that the need to control external documents is to ensure that the most current version of a method is referenced or appropriate manual is being used. Regulatory methods are used as references by the laboratory and testing is performed as per written SOPs that fall under our existing document control system and have scheduled reviews. The scheduled review of SOPs is used to ensure that the proper version of a method is referenced. While using the most current version of an analytical method is our typical practice, there are specific client needs and accreditation rules that require previous versions of a method to be used.

The technical areas are responsible for ensuring that all manufacturers' manuals are current and available to analysts. The vendor provides instrument manuals when new equipment is purchased or existing instruments are updated. These manuals are kept with the instruments to which they are associated.

5.0 SAMPLE HANDLING

5.1 Sample Collection

It is the responsibility of the client to send us representative and/or homogeneous and properly preserved samples of the system from which they are drawn. The laboratory assumes that all multiple sample containers with the same designator/description and bottle type contain a homogeneous, representative sample. We also assume that it is acceptable to deplete one container and move to the next, without implications unless otherwise indicated by the client.

The laboratory provides the appropriate sample containers, required preservative, chain-of-custody (COC) forms, shipping containers, labels, and custody seals. The laboratory also provides trip blanks and analyte-free water for field blanks. Preparation of methanol containers for field preservation of volatile soil samples is available.

Sample containers are purchased pre-cleaned by the supplier. For pre-preserved bottles, each lot of preservative is checked for contaminants before use. This also serves as a check on the associated containers. An annual bottle lot check is performed to evaluate the cleanliness of any containers not already covered by the preservative checks. The evaluation is to assess cleanliness to the laboratories' detection limits. These checks are processed through the LIMS as samples. Results are documented through the LIMS Analysis Report.

The laboratory provides instructions with all bottle orders that define how to sample, preserve, store, and ship the samples prior to their delivery at the laboratory. These instructions inform the client of the importance of proper sampling and advise them that non-compliant samples are rejected or reported with a qualifier.

If samples are collected by the laboratory personnel, applicable sampling methods are in place to perform the sampling operation.

As samples are analyzed at the laboratory, there are times when additional sample volume is necessary to complete testing or perform retesting. If this situation arises, "additional sample" is requested by the laboratory and/or submitted by a client to supplement current work being performed within our facility. Additional sample received is either assigned a new laboratory sample ID number and/or a comment noted on the final report to state that additional sample was received, depending on the situation. It is our goal to provide accurate traceability between sample submission and when testing is performed.

5.2 Sample Receipt and Entry

5.2.1 Sample Entry

Samples can be received at the laboratory 24 hours a day, 7 days a week, 365 days of the year. Receipt can occur in one of three ways:

- The laboratory courier services (i.e., Transportation Department)
- Personal delivery
- Commercial courier

All samples received for testing are delivered to the Sample Administration Department immediately upon arrival. This group is responsible for the unpacking and organizing of the samples. This process includes checking custody seals if present, paperwork agreement, signing the chain of custody, recording cooler temperatures, documenting the condition of containers, accounting for all sample bottles, and observing any safety hazards, and

reporting any problems to Client Services for communication to the client. This receipt process is documented in the LIMS.

5.2.2 Sample Entry

As soon as practical after sample receipt, all samples are entered into our LIMS. Samples awaiting log-in are stored in temporary holding areas, at appropriate storage conditions to maintain sample integrity. Samples scheduled for Volatile analysis are stored separately. If there is doubt about the suitability of items received or if items do not conform to the description provided or the testing required is not clear or specified, the client is contacted and the conversation documented.

At the time of entry, the LIMS assigns a unique laboratory sample number to each sample. This number is sequentially assigned and a label is generated and is attached to the sample container.

Samples are tracked to the minute upon arrival. This allows the client to see exactly how long it took the samples to pass through receipt, unpacking, and entry.

A sample acknowledgement is generated from the LIMS per sample entry group. Upon request, a copy of the Acknowledgement may be sent to the client on the day following sample log-in to confirm sample receipt and entry. Internally, appropriate personnel audit all applicable sample entry and client paperwork.

5.2.3 Sample Preservation Check

Support personnel check and document preservation of non-volatile liquid samples after the samples have been entered into the LIMS and before they are placed into storage. Any checks of volatile samples are performed and documented at the time of analysis.

5.2.4 Sample Rejection Policy

Any time a sample is received in a condition that does not meet the method, regulatory, or client requirements, the condition of the sample is clearly documented through the LIMS on a sample administration documentation log or sample problem form. This information is forwarded to the CSR and the client is contacted to discuss the best course of action. The client is given the option to resample or have the sample analyzed and reported with a comment.

5.3 Sample Identification and Tracking

A sample label is generated for each sample and, in addition to the assigned unique sample number, the following information is displayed on the label: client name, sample identification assigned by the client, sample collection information, bottle code ID, analyses requested, and any applicable notes to laboratory personnel. The label includes a barcode that is used to track this information about the sample/container and to trace each container's storage location.

To ensure accountability of results, the unique sample number assigned is used to identify the sample in all laboratory data documentation, including notebooks, instrument printouts, and final reports. The sample number is also used to identify additional containers of the sample that are created during sample preparation and analysis (e.g., subsamples, extracts, digests). Each container for a sample is tracked through the bottle code and an A.B.C… designator when there are multiple containers of the same type received. The link of the bottle code and sample number is used to identify which specific container was used for testing.

Routine sample tracking is documented using the Laboratory Sample Analysis Record (LSAR) which captures the date, time and analyst for each sample preparation and analysis. The information is compiled in the LIMS using electronic record tracking from the data upload and entry functions. This displays, per sample, on each Analysis Report.

5.4 Sample Storage

After sample entry, samples are placed in an assigned and identified storage location until needed for analysis. Room temperature, refrigerated, and frozen storage are available and samples are stored in accordance with regulatory, method, or client direction. The LIMS is used to assign storage locations, which assists in the orderly storage of samples. Sample storage locations are secured and monitored for accurate temperature control. Samples are stored separately from standards and reagents.

The central locked storage facility contains 3430 square feet of refrigerated space, including 2740 square feet equipped for automated sample retrieval. Samples are stored in the laboratory's automated storage and retrieval system (ASRS) or other assigned storage locations (separate volatiles areas) within the laboratory until completion of all analytical work.

When a sample is scheduled for analysis, the analyst requisitions it through the LIMS from the storage area. Barcode readers are used for LIMS documentation of the movement of the samples between storage and the laboratories. To maintain the integrity and security of the sample(s), the aliquot needed for analysis is removed and the sample(s) returned to storage as soon as possible

5.5 Sample Return/Disposal

Samples remain in the storage area following analysis until the testing results have been verified and the analysis report has been generated. On a regular basis, a list is generated from the LIMS that summarizes samples that can be removed from the storage area. At a minimum, water samples are held for 1 week and soil samples for 2 weeks after reporting before they would be eligible for disposal. Samples are either returned to the client or disposed of in accordance with local, state, and federal regulations. Removal of the containers from storage for permanent discard is also documented in the LIMS using the barcode reader.

Due to the variety of waste generated at the laboratory, several general categories of wastes and waste streams have been identified. Identification of waste occurs through information provided by the client, historical information, and/or analytical testing. The laboratory uses a sophisticated, computerized LIMS, which includes programming to assist in the identification of hazardous wastes at time of discard.

For reasons of environmental liability, client confidentiality, proprietary product formulation protection, etc., wastes generated by the laboratory are disposed of via incineration at EPA licensed facilities. The three exceptions include bulk neutralized acid waste, COD analysis waste, and lab pack waste containing mercury. None of these exceptions involve containers with client information.

5.6 Legal Chain of Custody

Samples being tested for litigation require locked storage and documentation of the time and personnel responsible when the sample was not in storage. This level of documentation is available upon client request and procedures to define these activities are in place and include the following:

- A chain-of-custody document is initiated for each bottle type submitted by the client.

- The chain of custody is signed each time the sample is stored, removed from storage, or changes hands.

- Clients requesting internal chain-of-custody documentation receive the completed forms after the analysis is complete.

5.7 Representativeness of Samples

Each analytical method provides specific procedures for ensuring that a representative aliquot of the sample is used for testing. These procedures include shaking water samples and mixing solid samples prior to removing an aliquot for testing. Analysts are also instructed in sampling techniques that prevent contamination of samples.

6 TECHNICAL REQUIREMENTS - TRACEABILITY OF MEASUREMENTS

6.1 Reagents and Solvents

The reliability of our analytical results can be directly affected by the quality of reagents used in the laboratory. Procedures are in place to address labeling, storage, and evaluation of these materials. Reagents and solvents include acids, bases, indicators, buffer solutions, colorimetric solutions (CS), test solutions (TS), and volumetric solutions (VS). The *Chemical Hygiene Plan* provides safety information in regard to the storage and handling of laboratory chemicals. All reagents are stored separately from samples.

Each analytical method includes a list of reagents needed to perform the test. Reagents/solvents are fully described, including chemical name, purity, and description of preparation. Where applicable, shelf life and storage conditions are also listed. The laboratory is responsible for checking that new supplies meet the method requirements. These checks are documented and maintained.

Departmental management ensures that an adequate inventory of reagents needed to perform testing is maintained. Reagents received at the laboratory funnel through the Shipping and Receiving Department and deliveries are verified and labeled with the date of receipt. Large volume reagents (e.g., solvents, acids) are stored in a building outside of the laboratory until needed for use.

In addition to the name and concentration of the reagent, all reagents are labeled with the manufacturer/vendor, storage conditions, the date opened, and an expiration or re-evaluation date. Before using any reagent, the analyst must ensure that the material was properly stored and labeled. If a reagent has passed its expiration date or shows signs of deterioration, the material is not to be used in the laboratory and must be discarded or segregated as expired. In some method development or research work, expired reagents may be used. These must be labeled as such or stored in a designated location.

If a re-evaluation date is reached before a reagent is completely consumed, the reagent will be inspected by physical observation for signs of degradation. Physical signs include, but are not limited to, color changes, clumping or other texture changes for solids and formation of precipitate in solutions. This evaluation is performed by an experienced chemist or microbiologist.

Subsequent reagent solutions or mixtures prepared at the laboratory are fully documented in a logbook and labeled to include: unique name, concentration, date prepared, name of analyst who prepared the reagent, storage conditions or reference to the logbook containing these details, and expiration/re-evaluation date. The information recorded allows these solutions to be traced to the original stock solution. The reference to the logbook is intended for use on containers that are too small to clearly document all of the information.

All reagent certificates and MSDSs are retained by the laboratory.

6.2 Media

Within the microbiology laboratory, procedures are in place to address preparation, labeling, storage, expiration, documentation, and quality/sterility evaluation requirements for these materials. These procedures are described in Appendix K.

6.3 Calibration Standards

Written calibration procedures are required, where applicable, for all instruments and equipment used in the laboratory. The source and accuracy of standards used for calibration purposes are integral to obtaining quality data. Requirements for calibration are provided in each analytical method including specifications for the standards used. Where available and practicable, calibration measurements made by the laboratory must be traceable to national standards of measurement (e.g., NIST). Certificates of Analysis (C of As) are maintained for each material, as applicable.

The laboratory's ISO 17025 and DoD accreditations require calibration materials to be certified and purchased from a reference material producer accredited to ISO Guide 34 and ISO 17025, when available. A list of accredited suppliers is maintained by QA. This is applicable to the tests under these scopes of accreditation and can be met through the stock standards used for calibration; a standard processed under the calibration such as an ICV or LCS; or comparison to a separate reference material at a frequency defined by at the test level (i.e. annually).

Standards are usually purchased from commercial supply houses either as neat compounds or as solutions with certified concentrations. Upon receipt at the laboratory, the material must be labeled with the date of receipt. The accuracy and quality of these purchased standards is documented on a C of A and these certificates are maintained on file in the laboratory. .

Most solutions and all neat materials require subsequent dilution to an appropriate working range. Records of all standard preparations include the dilution(s) made and a reference to the original and any intermediate mixtures. Solutions are labeled according to laboratory procedures and assigned unique names or code numbers that provide traceability to the original components.

All standards are stored separately from samples and in conditions as stipulated by the method or vendor (refrigerator, freezer, room temperature, etc.).

Each new preparation of standard is tested for integrity by comparison to standards from another source or previously prepared solutions. Standards are not used for sample analyses in the laboratory past their expiration date. In some method development or research work, expired standards may be used. These must be labeled as such or stored in a designated location.

6.4 Equipment and Instrumentation

The laboratory is equipped with all equipment and instrumentation required for testing the scope of work which it supports. All equipment and instrumentation is maintained in proper working order. A master list of our equipment and instruments is maintained by our accounting department and includes the date received and the condition at receipt (new v. used). Our major equipment and instrumentation capabilities are summarized in Appendix F. In addition, we have numerous other instruments including pH meters along with support equipment such as ovens, incubators, centrifuges, balances, etc.

6.4.1 General Requirements

- Equipment/instrumentation is assigned a unique designation. This unique number or system identification is used to track the equipment or instrument within data documentation.

- A maintenance logbook is established in conjunction with installation and is readily available to document all incidents and/or routine maintenance processes that pertain to the equipment or instrument as they occur. The corrective action taken, the date that the equipment/instrument is returned to service, and performance checks performed is documented.

- All test, measuring, and inspection of laboratory systems, equipment, and instrumentation used at the laboratory is routinely calibrated and maintained in accordance with applicable standard operating procedures.

- A member of the technical group, or designated individual, performs routinely scheduled maintenance and calibration of laboratory equipment and instruments as required by laboratory procedures. These activities are documented.

- If appropriate standards or expertise for calibration or maintenance are not available in-house, the operation is conducted by an outside service firm, with appropriate accreditation. Certificates or other data generated by the service firm are reviewed by applicable the laboratory personnel to verify acceptability. This information is maintained on file.

- All equipment or instruments taken out of service are tagged “DO NOT USE”. The following minimum information is documented on the tag:

- Date taken out of service

- Employee who took the equipment/instrument out of service

- Reason for tag-out

6.4.2 Standard Operating Procedures

Information regarding operation, maintenance, and calibration of equipment and instrumentation is found in the respective SOPs. The procedures include, where applicable, a routine schedule for preventive maintenance and calibration along with acceptance criteria and remedial action to be taken in the event of failure. These procedures are maintained in the document control system and reviewed on a regular basis to verify they remain current and accurate. Vendor supplied manuals are also available to provide additional information in regard to operation and maintenance.

6.4.3 Maintenance

- Instrument and equipment maintenance is performed as either a preventive or corrective operation.

- Preventive maintenance procedures and schedules are developed for each instrument or piece of equipment, where applicable. Preventive maintenance operations are performed by an analyst, equipment maintenance specialist, or contracted (manufacturer's representative or service firm personnel). Documentation is maintained in the associated maintenance log for the procedure(s) performed as part of the preventive maintenance operation. It is the responsibility of departmental management to ensure that a preventive maintenance schedule is addressed by a procedure where appropriate and is followed.

- Corrective maintenance is performed by an analyst, equipment maintenance specialist, or contracted (manufacturer's representative or service firm personnel) in response to indications of equipment or instrument malfunctions. The unit must be clearly tagged as out of service. All corrective actions taken to bring the unit back into service are documented in the associated maintenance log. After repair, further notation is made in the log regarding the functional status. Calibration activities are performed, as applicable, and documented in the log before the unit is placed back into service.

- A supply of commonly needed replacement parts is maintained by the laboratory.

- A preventive maintenance schedule for major instruments is given in Appendix G. Maintenance of equipment used in microbiological testing is documented in Appendix K.

6.4.4 Calibration

- Calibration is the establishment of, under specified conditions, the relationship between the values/response indicated by a measuring instrument or system and the corresponding known/certified values associated with the standards used. Some types of calibrations are performed with a set frequency (e.g. daily) while others provide intermediate checks to ensure that the instrument response has not changed significantly.

- All measuring and testing instruments and equipment having an effect on the accuracy, precision, or validity of calibrations and tests are calibrated and/or verified on an on-going and routine basis. Methods for calibration of instruments and equipment vary widely with the nature of the device and the direction given by analytical procedures, departmental procedures, manufacturer recommendations, or regulatory requirements. Frequency of calibration can also depend on additional factors including ruggedness of the instrument or equipment and the frequency of use.

- Departmental management is responsible for developing or acquiring written calibration procedures for the types of instruments and equipment employed within their area, as applicable. Procedures address the following aspects: description of the calibration method, frequency/schedule for calibration, acceptance criteria, and corrective actions if failure occurs.

- Calibration information is recorded in a logbook that is associated with the instrument/equipment and/or a calibration certificate is maintained and/or data is generated and filed to document the activity.

- Calibration measurements are traceable to national standards of measurement (e.g., NIST) where available. Physical standards, such as NIST certified weights or thermometers are re-certified on a routine basis. Calibration certificates are maintained on file, where applicable, to indicate the traceability to national standards of measurement. These physical standards are used for no other purpose than calibration.

- Calibration failures are documented in the associated logbook and/or within the data generated from the instruments or equipment. Management personnel perform an evaluation and review of failures and assess any potential impact the failure might have on previously generated data. The laboratory utilizes "real-time" controls to ensure the accuracy of the data. These controls are used to assist in assessing the impact of the situation.

- After repair, adjustments, or relocation that could affect instrument response, calibration/verification activities are performed, as applicable, before the unit is returned to service.

- Analytical data is not reported from instrumentation or equipment with noncompliant calibration unless the client has agreed to receipt of the data and appropriate comments are applied to the final Analysis Report.

- A summary of the calibrations for most major instruments and equipment is given in Appendix H.

- Procedures for calibration of equipment used in microbiological testing are documented in Appendix K.

6.5 Computerized Systems and Computer Software

6.5.1 Computer Usage

The laboratory provides computer equipment for employees to use as a tool in performing their work. Computer equipment is the property of the laboratory and used in accordance with defined terms and conditions. Our goal is to provide standard hardware and software that meets the needs of the user. The majority of desktop PCs in use are standardized using cloning software.

6.5.1.1 Physical Security of Computer Systems

It is company policy to protect computer hardware, software and data documentation from misuse, theft, unauthorized access and environmental hazards. The corporate computer area and computer "Hot-Site" is locked and requires identification/building card access. All vendors, contractors, or other visitors must be escorted into this area. Controlled access of the laboratory buildings is outlined in Section 3.2.

6.5.1.2 Passwords

Passwords are important for the security of company data and resources. The laboratory's primary network operating system is Windows and each employee must have a user ID and password combination to access the system. Other computer systems also require a user ID password combination for access. The following procedures apply regardless of which system(s) is being utilized:

- Passwords must be created as strong passwords in accordance with Eurofins Password Policy and must be kept confidential.

- Users must log-out of a system when not in use to prevent unauthorized access. In addition, the network access will automatically timeout after a set period of inactivity, requiring a user to log-in to access the system.

- Forgotten passwords can only be reset by the IT Department or by an appropriate System Administrator.

- Network and LIMS passwords automatically expire every 90 days. The computer prompts a user to change the password when the expiration date nears.

6.5.1.3 Viruses

The laboratory centrally and continuously monitors the computer network for computer viruses. Employees are prohibited from using the company's computer equipment to propagate any virus. Anti-virus software is employed to detect viruses on the Windows network. A notification is sent when there is a particularly dangerous or virulent data destructive program that employees need to be aware of. However, employees are instructed to always be cautious and observant even if there are no current warnings. Employees must report any virus concerns to the anti-virus administrator or IT Management as soon as possible. Employees who share files between their home computer and the laboratory should install anti-virus software on their home computer. If an employee does not have such software, the laboratory can suggest various no-cost anti-virus software products.

6.5.1.4 Internet and E-mail Systems

The e-mail system is used primarily for the laboratory's business purposes. The *Eurofins Lancaster Laboratories'*

Employee Handbook provides additional information in regard to system usage. Employee access to the internet is restricted to those employees who have a business need for it. All employees have access to e-mail. Access to the internet is configured through a user's Windows network account. All internet and e-mail activity is subject to monitoring. All messages created, sent or received over the internet are company property and can be regarded as public information. E-mail and website filtering software is utilized.

6.5.1.5 The Laboratory's Intranet (LabLinks)

The Intranet is designed to be a useful tool for employees to acquire company information and to provide a company communication system. The *Eurofins Lancaster Laboratories' Employee Handbook* provides additional information in regard to usage.

6.5.1.6 Software Policy

- Copyright laws protect software, and the laboratory's intent is to abide by all software agreements.
- Software purchases must be formally requested and approved by management and/or validation personnel, as necessary.
- All software is used in accordance with applicable license agreements.
- Employees are not to install any software on computer(s) unless authorized by the IT Department.
- Software upgrades must occur in accordance with applicable change control procedures.
- Employees must not give software to outsiders (e.g., clients, contractors), unless approval is granted by management.
- Users must not make copies of any licensed software or related documentation without permission. Any user that illegally reproduces software is subject to civil and criminal penalties including fines and imprisonment.

6.5.1.7 Computer System Backup, Data Restoration, and Data Archival

Mission critical data is stored on several computers throughout the laboratory. These computers are connected through the local area network. Selected files on these computers are backed up using an enterprise-level backup software program. The objective of this backup is to have the ability to restore data after a total loss (e.g., theft, fire, natural disaster). Procedures are in place to perform data backups and restores.

6.1.5.8 Remote Access to Computer Systems

Employees are able to remotely connect to the laboratory computer systems through an encrypted (SSL) login. When logging in, users are authenticated with their Windows Active Directory account and password.

6.5.1.9 Electronic Data

Instrument software used for processing data must, when available, have password access and audit trails enabled. All data processed through the LIMS includes tracking features to document who and when data was entered and/or changed.

6.5.2 System and Software Verification

The laboratory LIMS is an in-house developed program. The design and updates to the system are written following typical Software Development Life Cycle (SDLC) processes for initial planning through testing and implementation. Before a new computer system/program or significant modification of an existing system/program is implemented in

our laboratory, it is necessary to generate a plan to specify the level of documentation required for the new or updated application. Developers, affected area management, and QA personnel review and approve the documentation.

The following are the typical documents that are compiled for these updates:

- System Change Request document – used for documenting/tracking changes in the programming
- Requirements documents – Describe the required system functionality and specifications
- Design documents – System overview, screen design, report layout, data description, system configuration, file structure and module design
- Testing documentation for system development/verification – Structural testing of the internal mechanisms and user testing of the installation and system qualification
- Periodic Review documents – periodic retesting of the programs is performed to ensure that the systems remain in a validated state.
- Retirement documents – used for documenting when a program is taken out of service
- Standard operating procedures and/or manuals

6.6 Change Control

Procedures are in place to define how to maintain facilities, processes, instrumentation, equipment, computerized systems, and computer software in a validated or controlled state through a plan of change control. Successful changes require a thorough evaluation and testing for potential consequences prior to implementation. Planning, authorizing, testing, and reviewing of proposed changes are documented throughout the change process. Changes are planned or could be made in response to an emergency situation. The following "general" elements apply to changes, as appropriate:

- Request to perform a change
- Evaluation of a change
- Authorization of a change request
- Preparation for an authorized change
- Execution and testing of the change
- Documentation of the change
- Approval of the change
- Change implementation and follow-up (Formal approval of the change is performed by designated responsible individuals and QA.)

6.7 Labware Cleaning

Dedicated washroom personnel support the laboratory operations in regard to labware preparation, washing, rinsing, and drying. Labware can include, but is not limited to glassware, plastic ware, utensils, and pipettes. Procedures are in place to outline the washing process for each type of labware. Most labware is cleaned using a Miele glass washing machine. Some labware is still washed by hand and either air-dried or dried in specifically designed ovens.

Most of the labware used in the laboratory is “common or non-dedicated” labware (common to a department), but some of the labware used in the laboratory may be identified as “dedicated” labware and exclusively used for certain analyses. Examples of dedicated labware include glassware used for high resolution mass spectrometer (HRMS) and low level mercury testing. This labware is isolated and cleaned only with “like” labware.

All glassware is class A and 100% visually inspected for breakage (e.g., cracks, chips), cleanliness, and dryness before being returned to the laboratory for use.

Generally, each test has controls in place to ensure that results are not adversely affected by unclean labware. These controls include blanks to detect positive interferences and recovery controls to detect negative interferences.

7 PURCHASING EQUIPMENT AND SUPPLIES

7.1 Procurement

It is the responsibility of management personnel within each department to ensure that the appropriate supplies are available and/or ordered with sufficient lead-time to perform analytical testing or to provide support to the testing areas. The individual technical departments have trained personnel who enter the supply order into the company’s requisition software system. The selection of these products is based on technical input at the analyst level and authorized by technical departmental management. The Purchasing Department maintains an ordering system in which purchase requisitions are managed. Common laboratory items (e.g., beakers, flasks, reagents) are ordered directly through the Purchasing Department. Purchase orders over a specified dollar amount require verification from the appropriate member(s) of the Executive Management Group before an order can be placed.

Upon receipt of an order, the Purchasing Department checks the order to ensure that all items were received as specified. Products that have specific storage requirements are taken to the technical area upon receipt. It is the technical area’s responsibility to ensure that the product is stored in the appropriate manner. Any checks on the quality of the materials received for use in a specific test are the responsibility of the laboratory using them. This is based upon the experience of the laboratory with the usability of the product. Generally, each test has controls in place to ensure that test results are not adversely affected by the materials.

Any problems encountered when using a material in the laboratory must be brought to the attention of the Purchasing Department and/or Quality Assurance, as applicable, to ensure that follow-up and corrective action occur.

7.2 Supplier Evaluation

Procedures are in place to evaluate vendors who supply us with: new equipment, instrumentation, computerized systems and computer software; commercially purchased glassware, including sample bottleware, reagents, chemicals, solvents, gases, media, and standards; and contracted and subcontracted services.

The laboratory strives to ensure that our suppliers continually improve their quality systems and we reserve the right to purchase from suppliers of our choice in order to best fulfill the needs of our clients and our business. When directed by a client to purchase from a specific supplier, we will do so. In this instance it is the client's responsibility to "qualify" the specified supplier. We attempt to purchase from businesses that we have an established purchase history or have previously acquired information regarding the supplier's quality programs.

The laboratory does not evaluate every supplier. Risk assessment is taken into consideration when making this decision. The risk assessment analysis includes system, material, services, and number of samples or operations the purchase may affect or support. Evaluations are not required for computer operating systems, utilities, toolsets, or systems software. They also are not required for any off-the-shelf configurable software package that has an extensive market performance history (e.g., Microsoft Word, Excel, Access).

Additional quality systems are also in place within the laboratory to further verify and support the materials used:

- C of A for every lot of purchased prepared microbiological media and for purchased chemicals, where available, are reviewed and maintained on file.

- For most chemical analyses a blank and a recovery check are routinely analyzed and serve as real time suitability testing of the reagent being used.

- Microbiological testing often employs positive and negative controls, which serve as real time control checks.

8 ANALYTICAL METHODS

8.1 Scope of Testing

Samples are analyzed in accordance with official published methods, standard methods, client-supplied methodology, or validated in-house methods. We recognize the importance of providing verifiable results and, therefore, use methods accepted and approved by a broad range of federal and state regulatory agencies. In order to meet the needs of our clients as well as regulatory agencies, the laboratory sometimes needs to support different versions of the same method (i.e. SW-846 8081A and 8081B). The laboratory can also assist in developing and validating analytical methods for specific products and matrices. All methods submitted for our review, as well as all analytical results, are considered confidential.

The laboratory performs a wide variety of environmental testing in support of the Safe Drinking Water Act (SDWA); Clean Water Act (CWA); Resource Conservation and Recovery Act (RCRA); Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA/Superfund); and the Clean Air Act (CAA). Methods approved by ASTM are also used in testing. Potable water, wastewater, soil, sediment, sludge, oils, biota, tissue, soil gas, and air are among the matrices typically analyzed.
Our areas of expertise include:

Standard Services	Specialty Services
• Volatiles • Semivolatiles • Metals • Pesticides/PCBs/Herbicides • Petroleum Analysis • Waste Characterization • Non-potable Water Testing • Drinking Water • Soil and Surface Water Testing • Vapor and Air Analysis • Sediment and Tissue Testing • Method Development • Shale Oil & Gas Analysis •	• Low-Level Mercury • Dioxins & Furans • Hydrazines and NDMAs • Perchlorate • 1,4-Dioxane • Pharmaceutical Manufacturing Industry (PMI) Wastewater • EPA Method 25D • PCB Congeners • Explosives • Alkyl PAHs, Alkanes, Biomarkers • PFC (PFOA) • Organic Acids • Aldehydes •

A list of tests covered under the laboratory's NELAP accreditation can be found in Appendix I. All current certificates and scopes of accreditation are available on the laboratory's website at http://www.eurofinsus.com/environment-testing/laboratories/eurofins-lancaster-laboratories-environmental/resources/certifications/. A complete list of the tests routinely performed by the laboratory can be found in the *Schedule of Services*.

8.2 Analytical Test Methods

Each laboratory is required to establish and maintain analytical procedures for all the methods referenced in standard testing. The sources for these methods include the most recent versions of these compendia:

- Test Methods for Evaluating Solid Waste, SW-846
- Standard Methods for the Examination of Water and Waste
- Code of Federal Regulations, Chapter 40
- EPA 100 through 600 and 1600 series methods
- ASTM

The test methods used are re-written into a laboratory standard format, which provides consistency in content and allows the analysts to locate the information they need quickly. Procedures are in place to define the format, required approvals, and the control system for these method documents. Elements to address in SOPs are based on TNI and DoD required sections. The format requirements include, but are not limited to, the following:

- Uniquely assigned method number, which is used extensively for scheduling and documentation purposes.
- Reference to the original source of the method (e.g. SW-846)
- Scope
- Basic Principles
- Apparatus and Reagents
- Personnel Training and Qualifications
- Safety and Waste Disposal
- Detailed procedure (including any method modifications)
- Calculations
- QA/Quality Control
- Revision Log
- Approval signatures from technical management and QA personnel

Analytical methods are maintained as controlled documents to ensure that analysts are always working with the most current version and are reviewed periodically for accuracy.

8.3 Client Supplied Methods

Most of the client-supplied method requirements presented to us involve achieving specific quality control criteria, limits of quantitation (LOQ), and/or method detection limits (MDL) using standard EPA methods. These requirements are communicated to the appropriate technical groups prior to the project start up. Each technical group evaluates the scope of work and the requirements to ensure the criteria can be met using the standard EPA method. The data is monitored to ensure the criteria are met throughout the project. The CSR notifies the client if there is a more appropriate method available or if the client's criteria cannot be achieved on a certain sample matrix (i.e., due to matrix or dilutions).

Occasionally, we are asked to transfer a non-standardized method from a client into our lab or to develop a new method, when one is not available. In the case of a method transfer, we set up the client's method and perform some initial evaluation. After the initial evaluation, we may make recommendations on how to improve method performance. If the method appears to be adequate, we determine linearity, specificity, precision, accuracy, MDL, and LOQ by performing calibrations, analyzing method blanks, and carrying out method detection limit and quad studies.

In the case of method development, we work with the client and/or data user to determine the level of validation required ensuring that the method meets its intended purpose. In addition to the elements above, we also determine standard and sample stability and robustness depending on the scope of the project. Typically, a

standard operating procedure is written and submitted to the client with the results of the validation. These steps are completed prior to analysis of field samples. Data related to the setup of the method are archived.

8.4 Method Validation

Before new or revised analytical methods are authorized for routine use in the laboratory, validation data is required to demonstrate that the method as performed in our laboratory and analysts performing it are capable of meeting data quality objectives for precision and accuracy. A procedure is in place to outline this process.

Many methods published by USEPA include instructions for performing an initial demonstration of capability, which typically consist of determining the method detection limit and analyzing fortified samples in quadruplicate. This demonstration is performed and compared to acceptance limits for precision, accuracy, and detection limits, when available.

Methods that do not include specific validation requirements are validated by analyzing fortified samples or standard reference materials in replicate. The results of these analyses are used to assess accuracy and precision. Results of validation studies are documented and subject to review and approval by technical and QA management.

8.5 Procedural Deviation

Analysts are required to follow a documented method for all tests performed. Procedures are in place to ensure that deviations from analytical methods are documented, approved, and justified in an appropriate and consistent manner (Note: Deviation from the OH EPA approved SOPs is not permitted). We classify method deviations as either being a planned deviation or an unplanned deviation. In general, the following information is captured to document both types of situations:

- Description of the deviation
- Reason or justification for the deviation
- Impact the deviation had on the testing
- Signature/date of analyst performing the test
- Signature/date of Quality Assurance and Laboratory Management approving the deviation
- Signature/date of client approval, if necessary

Deviations to written procedures are documented in raw data records or through the ICAR (Investigation and Corrective Action Report) system. Both types of documentation require management and QA review and approval.

9 INTERNAL QUALITY CONTROL CHECKS

9.1 Laboratory Quality Control Samples and Acceptance Criteria

Quality control (QC) samples are analyzed with each batch of samples to demonstrate that all aspects of the analysis are in control within established limits of precision and accuracy. Management is responsible for ensuring that QC is analyzed as required by the referenced method. Each analytical SOP specifies (or cross-references

another procedure) the type of QC sample, frequency of analysis, acceptance criteria for QC sample results, and corrective action to be taken if QC sample results fall outside of the acceptable range.

QA staff, at the direction of the technical department, must program the LIMS with the acceptance criteria for each QC type (other than blanks). The acceptance criteria are based on statistically generated limits from historical laboratory data, on method defined limits, government agency recommendations, or on client/project specific limits.

These limits are used to flag samples that are out of specification.

The types of QC samples and the information each provides are discussed in the following paragraphs.

Quality control checks used for microbiological tests can be found in Appendix K.

9.1.1 Blanks

A blank is a designated sample designed to monitor for sample contamination during the analysis process. The blank consists of a clean matrix (i.e. reagent water, Ottawa sand, glass beads, Teflon chips) taken through the entire sample preparation and analysis process. The blank and field samples are treated with the same reagents, internal standards, and surrogate standards. Ideally, blanks demonstrate that no artifacts were introduced during the analysis process. The specific acceptance criteria for each test are usually based on the required reporting limit (MDL or LOQ).

9.1.2 Surrogates

Surrogates are organic compounds, which are chemically similar to the analytes of interest but are not naturally occurring in environmental samples. When required by the analytical method, surrogates are spiked into all the field and QC samples to monitor analytical efficiency by measuring recovery on an individual sample basis. The percent recovery is determined and compared to the acceptance criteria.

9.1.3 Matrix Spikes

A matrix spike sample is created by fortifying a second aliquot of a water or soil sample with some or all of the analytes of interest. Blanks are not used for matrix spike QC. The concentration added is known and compared to the amount recovered to determine percent recovery. Matrix spike recoveries provide information about the potential matrix effects on the data. Matrix effects can cause results to be outside of the acceptance criteria.

9.1.4 Laboratory Control Samples

Laboratory control samples (LCS) are samples of known composition that are analyzed with each batch of samples to demonstrate laboratory accuracy. Laboratory fortified blank (LFB) is another term used to describe a LCS. The samples are clean samples fortified with known concentrations. Percent recovery is calculated and compared to acceptance

9.1.5 Duplicates and Matrix Spike Duplicates and Laboratory Control Sample Duplicates

A duplicate is a second aliquot of a sample that is treated identically to the original to determine precision of the test. To compare the values for each analyte, the relative percent difference (RPD) is calculated by dividing the difference between the numbers by their average. Precision for analytes that are not typically found in environmental samples (i.e., organic contaminants) is determined by analyzing a pair of matrix spike duplicates, defined as two spiked samples and comparing the RPD for the spiked compounds. The acceptance criteria are described as a maximum for the RPD value.

9.1.6 Internal Standards

Internal standards are organic compounds, which are chemically similar to the analytes of interest but are not

naturally occurring in environmental samples. When required by the method, internal standards are added to every field and QC sample after extraction but prior to analysis. Comparison of the peak areas of the internal standards is used for quantitation of target analytes. Internal standard peak area and retention time also provide a check for changes in the instrument response. The acceptance criteria are stipulated in the analytical method.

9.1.7 Serial Dilutions

A serial dilution is the dilution of a sample with sufficiently high concentration by a factor of five to check for the influence of interferents. This QC check is performed for inorganics analyzed by ICP or ICP-MS. When corrected by the dilution factor, the diluted sample result must agree with the original sample within method specified limits.

9.1.8 Interelement Correction Standard

Analyzed to verify interelement and background correction factors. A solution containing both interfering and analyte elements of known concentration is analyzed at the beginning and end of each analytical run or a minimum of twice per 8 hours.

9.1.9 Second Source Check

A second source check is analyzed using either the LCS and/or an Initial Calibration Verification (ICV). The second source is a standard that is made from a solution or neat purchased from a different vendor than that used for the calibration standards. For some custom mixes, the same vendor but a different lot and preparation is used. This ensures that potential problems with a vendor supply would be evident in the analysis. Some tests use the continuing calibration verification standards as a second source from the initial calibration.

9.2 Quality Control Sample Frequency and Corrective Action

Each analytical method defines the frequency for the required QC samples and the corrective action required when a QC result fails to meet the acceptance criteria. A summary is provided in Appendix J.

The QC acceptance criteria are available to analysts in the laboratory. If the method reference requires the use of specific limits then the laboratory uses the published limits that are documented as part of the analytical method. Many methods require that each laboratory determine their own acceptance criteria based on statistical data obtained from performance of the method. In these cases, the limits are available to the analysts and are entered into the LIMS described below. Statistically determined acceptance criteria are subject to change as the laboratory recalculates its control limits. Due to their dynamic nature, acceptance criteria are not included in this manual.

The results of all quality control samples are entered into the LIMS in the same way as the results of client samples. The LIMS compares the individual values with the acceptance limits and identifies quality control sample results that are out of specification. If the results are not within the acceptance criteria, corrective action suitable to the situation must be taken. This includes, but is not limited to, checking calculations, examining other quality control analyzed with the same batch of samples, qualifying results with a comment stating the observed deviation, and reanalysis of the samples in the batch.

Each month, a summary of all QC entries (except blanks and surrogates) is generated from the LIMS. This summary is reviewed by QA staff and evaluated for changes in data that may indicate that an analysis is trending towards an out-of-control situation. The technical department is notified if a trend is observed.

The laboratory allows for marginal exceedances based on the number of analytes in the LCS. The exceedances are carefully monitored so that any systemic problems would be identified and corrective action taken. If the LCS is being reported based on the marginal exceedance allowance, a comment is added to the analytical report. Note: The use of marginal exceedance is not allowed for OH VAP work.

9.3 Quality Control Charts

The LIMS quality control system is used to report QC data to clients, to collect data for assessment of precision and accuracy statistical limits, and to generate control charts. Control charts are accessible to all employees through the LIMS interface. The system charts results from blanks, surrogates, matrix spike/matrix spike duplicates, duplicates, and laboratory control samples/laboratory control samples duplicate. These charts provide a graphical method for monitoring precision and bias over time. They can be used to detect quality problems by observation of patterns. QA staff uses the charts in conjunction with a LIMS generated monthly QC trend report to evaluate potential data trends.

9.4 Measurement Uncertainty

(ISO 17025) "All uncertainty components which are of importance in a given situation shall be taken into account using appropriate methods of analysis" (5.4.6.3). This means the laboratory must determine the uncertainty contribution of all steps in the testing process such as equipment, calibration, standards, reagents, preparation, cleanups, etc. Since, in most methods, the laboratory control sample (LCS) goes through the entire process of preparation to analysis; all factors that would contribute to uncertainty is evident through the LCS results. LCSs are performed with every batch of samples where appropriate for the method. Tests that do not have LCSs (i.e. TCLP; paint filter test), are evaluated on a case-by-case basis by taking into account the uncertainty of each of the steps taken to perform the test.

Measurement Uncertainty reports are generated by each technical department on an annual basis using a LIMS program and submitted to QA. Measurement Uncertainty is calculated as two times the standard deviation of the LCS recoveries for the group and date range of data points selected for all applicable methods. This is reported as a percentage. It is not necessary to apply or report the uncertainty value with sample results. When a client requests the measurement uncertainty it is applied by multiplying the determined analyte concentration by the uncertainty percentage.

10 ASSURING QUALITY OF TEST RESULTS

10.1 Data Management

At a minimum, data management is initiated when the laboratory receives the samples from the client. More often the process begins with client communication of their needs and requirements for a specific project and/or testing. When requested, bottle orders for the client's sampling efforts are generated through the LIMS by the CSR. The CSRs are responsible for entering the information in the sample set up function of the LIMS. Upon receipt of the samples a unique tracking number for the sample group and the samples within the group is generated based on this information. At this point, the LIMS becomes an integral part of tracking the samples through laboratory operations. The flow of data from the time samples enter the laboratory until the data is reported is summarized in the following table:

Sample and Data Flow

Action	Personnel Involved
Bottle orders generated upon request • Bottles packed and shipped to the client under chain of custody documentation	Client Service Representative Bottles Preparation
Sample received at Lancaster Labs • Unpacked and reconciled against the client paper work or COC • Sample Entry Documentation log completed	Sample Registration

Action	Personnel Involved
Sample is entered into the LIMS • Lab ID number assigned • Analyses entered • Storage location assigned • Electronic record of sample number • Labels generated • Acknowledgement printed (record of samples received and analyses entered)	Sample Registration
Preservation checks performed Sample stored in assigned location (refrigerator, freezer, etc.) • Electronic record of sample #, bottle code, and location	Sample Registration
Acknowledgment sent to client (when requested)	Sample Registration
Samples requisitioned and removed from storage for analysis • Electronic requisition of sample number by bottle code • Necessary aliquot taken • Remaining sample returned to storage	Sample Registration Technical Personnel
Analysis is performed according to selected analytical method • Raw data recorded • Data Reviewed • Data uploaded to the LIMS from the instrument or manually entered by the analyst* (This is tracked by the unique sample number and batch number.)	Technical Personnel
LIMS performs calculations as programmed according to methods	Data Processing
Designated analyst or supervisor verifies raw data	Technical Personnel
Generation/release of reports (automated through LIMS)	Billing and Reporting Group
Data package deliverables are assembled, reviewed and released to client Electronic copy saved in the LIMS	Data Package Group
Electronic Data Deliverables (EDDs) are generated	EDD Group
Designated Data packages are overchecked by QA prior to release	QA
Hard copy of batch raw data is archived Electronic files are backed up and archived	Technical Personnel, Data Package Personnel, Office Services, IT

*Analyses requiring the analyst's interpretation may involve manual data reduction before entry into the LIMS.

10.2 Data Documentation

Analytical data generated in the laboratory is collected from the instruments or associated data system or is manually documented in bound notebooks. Analysts review data as it is generated to determine that the instruments/systems are performing within specifications. If any problems are observed during an analytical run or the testing process, corrective action is taken and documented.

Procedures are in place to ensure that all data is traceable, authentic, and complete. Electronic data records are maintained and tracked through the LIMS, requiring authorized, password protected user access. The following general requirements outline our system for notebook, logbook, and documentation recording:

- Observations, data, and calculations are recorded at the time they are made and are identifiable to the specific task.

- Entries must be legible, signed, and dated. The signature may be a wet or electronic signature.

- Errors are corrected in a manner that does not obliterate the original entry, initialed and dated, and coded with an explanatory identifier. Changes to electronic data are tracked through audit trail functions.

- Blank pages or substantial portions of pages which are left blank are crossed-out to eliminate the possibility of data entry at a later date.

- Notebook pages and instrument printouts are signed/dated to indicate second party data review; this may be a wet or electronic signature.

- At periodic intervals a supervisor or data reviewer checks equipment/instrument logbook entries and temperature recordings for completeness, legibility, and conformance to procedures.

- At a minimum, the following information is recorded as part of data documentation:

  - Date of analysis/operation

  - Signature/date of analyst performing test/operation

  - Identification of client sample(s) and material(s) analyzed

  - Materials, reagents, standards used to perform the testing/operation

  - Method used to perform testing/operation (including version number and/or effective date)

  - Equipment/instrumentation used to perform testing/operation

  - Calculations and how they were derived

  - Departures, planned or unplanned, from the analytical method

  - Signature/date of person reviewing data documentation

- For computer generated data, the following information is recorded:

  - Sample(s) analyzed/operations performed

  - Date of analysis/operation

  - Unique instrument identification

- Name/date of person operating the instrument
- Name/date of person reviewing data
- Any manual notations or interpretations made on instrument printouts are signed, dated, and reviewed

10.3 Data Calculations

Most instruments either include or are connected to a data system programmed to perform calculations to reduce the raw data to a reportable form. All calculations are maintained in the instrument manuals and/or as part of the analytical method.

In many cases, the data from the local instrument system are uploaded directly to the LIMS for review and reporting. This direct upload eliminates the need to retype data and an associated source of transcription errors from the analytical scheme.

Some instruments report data that require application of additional factors before the data is in final form. For example, an extract concentration may be reported by the instrumental data system, but additional dilution and preparation factors may be needed before the result represents the concentration of analyte in the sample. Analysts input these additional factors into the LIMS, where final calculations are performed.

Analysts manually enter collected data, such as titration data, into the LIMS, which is programmed to perform calculations for final reporting. Documentation of the programming for each calculation performed by the LIMS is maintained.

10.4 Reporting Limits

It is important to ascertain the limit of quantitation (LOQ) that can be achieved by a given method, particularly when the method is commonly used to determine trace levels of analyte. The Environmental Protection Agency has set forth one method for determining method detection limits (MDLs) from which LOQs can be extrapolated. This process is summarized in a laboratory procedure.

MDLs are verified or determined annually on each instrument and are the basis for the LOQ used in the default reporting format. Because MDLs change each time they are re-evaluated, they are not included in this manual, but are available in each laboratory and available to clients upon request.

The reporting limit used to determine whether a result is significant and reported as detectable is dependent upon agency and client requirements. A variety of formats are available and include use of the MDL, LOQ, method specified limits, and project specific limits. The MDL and LOQ for each analyte are programmed into the LIMS for reporting purposes.

Under the DoD program, the laboratory must establish a Detection Limit (DL) and Limit of Detection (LOD). As defined by the DoD program, the DL is the smallest analyte concentration that can be demonstrated to be different from zero or a blank concentration with 99% confidence. The laboratory determines the DL using the calculated value from the MDL Study. The DL can be derived from pooled MDL values obtained across instruments. The LOD is the smallest amount of a substance that must be present in a sample in order to be detected at the DL with 99% confidence. It is established by spiking a quality system matrix at a concentration of 2-4 times the DL. The LOD must be verified on a quarterly basis or with each batch of samples.

10.5 Data Review

Final review and verification of the data are performed by designated employees using the sample results, quality control information, method criteria and Project Notes entered into the LIMS. Data are initially evaluated by the analyst and then a second designated employee knowledgeable in the test, other than the employee responsible for performing the test, reviews the data. The reviews include checks for correct transcription, calculations, passing calibrations, compliant quality control results, holding time compliance, and project specific requirements. Any issues or errors identified during this stage are addressed, corrected, and reviewed with the responsible person.

After determining that all necessary requirements for valid data and for the project are met, the reviewer electronically approves the data by changing the LIMS status of the data from "complete" to "verified". The LIMS is programmed with a list of approved reviewers for each test, and the system is password protected to ensure that only qualified individuals verify the data.

10.6 Data Qualification

Data qualifiers are used to provide additional information about the results reported. The most typical use for data qualifiers is for results that fall below the quantitation limit, in the region where it becomes more difficult to distinguish a positive result from the background instrument signal. The data systems used to generate and report results are programmed to flag values in this range as estimates.

Other qualifiers are applied to advise data users of any validation issues associated with the data. The laboratory makes every effort to meet all of the requirements for generation of data. Occasionally, generation of data that does not meet all the method requirements occurs due to sample matrix or other analytical problems. If the test cannot be repeated or reanalysis would not yield better quality data, qualified data is reported. Qualifiers can be in the form of comments on the analytical report or flags applied to the results.

10.7 Data Reporting

When all analyses are completed, reviewed and verified, a report is generated by the LIMS. The client receives a copy of the report containing the results of the analysis, associated QC data, and where necessary, explanatory comments to address non-conformances. To avoid ambiguity in interpreting results, a summary page that contains an explanation of all symbols and units used in reporting data is included with the Analysis Report submitted to clients. Some regulatory agencies also require the laboratory accreditation identification on the Analysis Reports. Where required, this information is added. The current list of agencies can be accessed in the LIMS. Copies of reports and associated supporting raw data are retained in our archives. The report contains the signature of the assigned client service representative who is the key contact for any questions concerning the results. Personnel authorized to review, sign, and release Analysis Reports are noted in the key personnel list provided in Appendix C.

The laboratory offers a variety of data reporting .levels and formats, from a basic report of sample and QC results only, to a comprehensive data package of QC/calibration information and raw data. The client and any agency involved direct the selection of report type. A summary of report formats and data packages types is provided in the laboratory *Schedule of Services.* Various electronic formats are also available formatted to client-specified file structure and sent via e-mail, direct upload, web-site access (LLabWeb), or common courier. LLabWeb is used for clients that require secure transfer of electronic data.

Client confidentiality of LLabWeb data is ensured by the use of a secured firewall internet environment coupled with the use of a user ID and password to gain login access to the system. User accounts are configured to only allow access to specific data associated with the user's business account number.

Amendments to a final report after issue are in the form of an additional document or data transfer and include a reference to the original report. When a completely new final report is required, it is uniquely identified and includes a reference to the original report it replaces.

10.7.1 Reporting the Results

Analytical reports are generated with a cover page that summarizes all samples in that group. This page lists the laboratory assigned sample number and the corresponding client description. The cover page identifies the laboratory contact person's name and phone number if there is a question about the report. Within this package, each page is uniquely identified and paginated. Analytical test results for methods listed on the laboratories' accreditation scope meet all requirements of NELAP accreditation and ISO 17025 unless noted otherwise. Ohio EPA VAP requires that a signed, notarized affidavit accompany each analytical report.

10.8 Data Storage, Seucirty, and Archival

The laboratory has documented procedures and instructions for the identification, collection, access, indexing, filing, storage, maintenance, and disposition of data records. Records are in the form of paper records, electronic data files, magnetic tape, and CD-ROMs.

All data records are maintained in a confidential manner in an environment to minimize deterioration or damage and to prevent loss. Some records are stored in off-site facilities, in such a way that they are readily retrievable. Retention time for records is in accordance with specific procedures or instructions. Prior to the destruction of data/records, and if requested by a client or agency, the laboratory will notify the client/agency that their data is scheduled for destruction so arrangements can be made to have the original data sent to the client.

If specified in client contract(s), archived records are transferred according to their instructions in the event of a change in laboratory ownership or if the laboratory goes out of business. If not specified by the client, the sale agreement must require that archived records be maintained as scheduled by the new owners. In the case of bankruptcy, appropriate regulatory and state legal requirements concerning laboratory records must be followed.

The laboratory maintains all documentation which is necessary for historical reconstruction of data:

- Analysis reports
- Data notebooks
- Data logbooks
- Instrument output
- Correspondence and client files
- Instrument and equipment logbooks
- QA records

- Corporate documents
- Electronic records

11 AUDITS AND INSPECTIONS

11.1 Internal Quality Assurance Audits

The QA Department, which is independent of laboratory activities, performs routine and on-going system, traceability, and observation audits to objectively review current systems, operations, and procedures as well as automated data integrity audits of electronic data records. The goal of the audits is to ensure that the quality system activities are effective and in compliance with regulatory programs, including NELAP. ISO 17025, DoD, and state agencies, as well as internal policies and procedures. Audits are documented and tracked in a QA database.

Audits are scheduled and conducted following a predefined schedule, based on criticality of operation and prior audit results, with the goal of evaluating systems and technologies across the operation. If warranted, additional audits are performed to follow up on promised corrective action or areas of concern.

Results of an audit are documented in a report format and distributed to applicable management personnel responsible for the area(s) under audit. Management is responsible to address all non-conformances found during an audit with root cause analysis and application of a corrective action plan.

Audit reports and responses are circulated to Management to communicate the outcome of the audit and the proposed plan(s) for corrective action, if warranted. If any of the audit findings cast doubt on the validity of the results, the clients must be notified within three business days of the investigation. Should an audit issue present a major concern regarding validity of laboratory methods, QA personnel can issue a stop work notice.

All records maintained as part of an audit are kept on file for three years.

On an annual basis, an audit of the QA Department is performed as directed by the laboratory's Executive Management. The auditors assigned to carry out this operation are qualified staff members independent of the QA Department.

The specific content and findings of internal audits are considered company confidential and are not shared with clients.

11.2 Review of the Quality Assurance Program

All levels of management are continually updated on the status of quality and compliance by circulation of pertinent documents. Management review is documented by signatures on the documents, electronic records of each person's review, along with any comments or request for additional follow-up. The types of documents circulated real-time include:

- Internal, client, and agency audit reports and responses
- Proficiency test results
- Investigation and corrective action reports
- Monthly QA status reports

Executive management reviews the elements of the total QA program on an annual basis to ensure its continuing suitability and effectiveness in meeting the stated objectives outlined in Section 2.4 of this manual. The evaluation entails review of reports to management, all audit findings, client complaints, laboratory investigations, staff adequacy and training, and projected growth in workload. Patterns or trends in any of these areas are reviewed as a means to continually improve the quality system. This review also includes an evaluation of any audit findings resulting from the audit of the QA Department. At the conclusion of this quality system review, executive management determines the need to introduce changes or improvements into the quality systems at the laboratory. The minutes from the meeting and any recommendations for improvement are documented and a copy is forwarded to the QA staff for review and follow-up.

11.3 Good Laboratory Practice Critical Phase Inspections

Any project that is subject to Good Laboratory Practice (GLP) regulations is audited by the QA Department, as required by the regulations, at intervals adequate to ensure the integrity of the study. Inspections of a GLP project include direct observation of analysts as they perform various phases of the study. Data documentation is reviewed as part of the inspection. The purpose of this type of audit is to ensure that there are no deviations from written methods, procedures, or study protocols.

Results of inspections are documented in a report format and distributed to applicable management personnel responsible for the area(s) under audit. Management is responsible to address all non-conformances found during an inspection. Inspection reports and responses are circulated to applicable laboratory management and an off-site study director, as applicable, to communicate the outcome of the inspection and the proposed plan(s) for corrective action, if warranted.

All records maintained as part of an inspection are kept on file.

11.4 Client Audits

Because clients place great importance on compliance with applicable regulations, data quality, and project requirements, they may audit our facility as assurance that their objectives are being met. QA, management staff, CSRs, and the analytical laboratories play a key role in these audits. Visits by clients can range anywhere from a tour (to verify laboratory facilities and instrumentation) to an intensive inspection of technical operations, procedures, regulatory compliance, and/or review of specific project(s).

- Audits are scheduled directly with the CSR or QA. The request to audit is communicated to all applicable laboratory departments.

- In accordance with our policy on client confidentiality, a client is permitted to review only data and results that apply to their work, or which have been approved by laboratory management.

- An escort (designated laboratory employee) remains with an auditor at all times.

Responsibilities are assigned to the following groups in regard to client audits:

11.4.1 QA Department

- Research previous audit reports and laboratory responses to past deficiencies.

- Follow-up with the applicable analytical laboratory areas to ensure action items were completed from the last audit, as necessary.
- Work with client to set audit agenda.
- Function as an escort during the audit
- Answer questions the auditor has in regard to laboratory and quality systems.
- Take notes of areas where corrective action or suggestions are recommended during the audit.
- Communicate audit issues to management at the completion of the audit.
- Respond to client audit reports.
- Ensure follow-up to cited items are addressed in a timely manner.

11.4.2 CSRs

- Gather and organize relevant information (e.g., client correspondence, analysis/project requests, copies of analytical data from archives).
- Be knowledgeable about client-specific project requirements and issues.
- Function as an escort during the audit.
- Communicate issues/problems to appropriate personnel.

11.4.3 Laboratories

- Gather and organize laboratory data and documentation in preparation for client review.
- Assure corrective action was implemented from past audit findings, if necessary.
- Be prepared to discuss project data/testing results during the audit.
- Be familiar with client-specific project requirements and be prepared to answer client questions.
- Be familiar with the location of routine laboratory information and equipment (e.g., SOPs, data notebooks, calibration data, etc.).
- Be prepared to answer specific technical questions in regards to laboratory procedures and instrumentation within the area.
- Functions as an audit escort within the department during the audit.
- Laboratory managers may function as an escort during the audit

11.5 Agency Inspections

It is laboratory policy to cooperate to the fullest extent and maintain cordial relations with all government agencies. The QA Department is assigned the responsibility of hosting and working with agency representatives. Their role includes, escorting the investigator(s); ensuring all questions are answered promptly and accurately; making note of all unresolved issues; informing management of the audit status and outcome; responding to the audit report and ensuring that appropriate corrective action is completed.

Inspections can be performed by investigators or auditors from the EPA, states, third-party accreditation bodies (i.e. A2LA, United States Department of Agriculture (USDA), or other regulatory agencies.

Government agencies have the right to investigate and inspect the laboratory during normal business hours and permission to inspect is granted by Executive Management.

Designated members of the QA Department are primary contacts for announced inspections. The QA Director is the primary contact for all unannounced agency inspections. If the QA Director is unavailable, Executive Management is notified, in addition to a member of the QA Department. The QA Director, or their designee, must obtain evidence of the investigator's authority either in the form of a letter or examination/explanation of credentials.

Inspections include the examination of records or the inspection of facilities. Investigators are usually concerned only with the records relating to their responsibilities. As a general rule, they are given copies of records and documents, if requested. The laboratory must have a record of all items provided to an investigator.

Investigators must be escorted through the laboratory. The laboratory is not obligated to show an investigator the following types of information: sales, financial or pricing information, or any personnel data other than training or qualification documentation. On a case-by-case basis, internal QA audit reports and investigation reports are made available for agency review. Any questions or concerns about a request made by an investigator in regard to recording devices or photographs must be reviewed with legal counsel.

The laboratory personnel are not permitted to sign affidavits. If an affidavit is presented during an inspection, all personnel are directed not to sign it, read it, nor listen to it being read. The only document that is acceptable to sign is an acknowledgement that an inspection report has been received. If there is any doubt as to what should be signed, legal counsel must be consulted.

11.6 Proficiency Testing

Many of the organizations that certify our laboratory to perform various analyses require proof of our competency. Laboratory performance is checked regularly by participation in a variety of proficiency testing (PT) programs. When available, blind samples are obtained from vendors that are accredited to provide PT samples under the TNI and/or ISO 17025 standards for all test and matrices routinely tested at the laboratory. In addition, some individual certification programs require analysis of specific sets of proficiency samples. The laboratory also chooses to participate in a double blind program.

Generally, the PT programs consist of samples or ampulated spiking solutions used to fortify laboratory samples. The laboratories analyze the samples in the same manner as a client sample and the data is sent to the agency or vendor for evaluation. After the study results are returned to the laboratory, any data falling outside the acceptance criteria is investigated, root cause is identified, and corrective action is implemented, if needed.

Results are circulated to management. No PT samples or portion of a PT sample are sent to another laboratory for analysis.

Double blind samples are submitted to the laboratories by the Client Services Department using a fictitious client name so that the analysts are not aware that the samples are PTs. The samples are submitted quarterly and include a cross-section of organic and inorganic tests. The acceptance criteria for these double blind samples are developed statistically using data from participating laboratories, providing a source of inter-laboratory comparison. Results are reviewed, investigated as needed, and circulated to management.

If a trend in PT failures is identified, additional blind samples are ordered for that specific test as corrective action.

Clients routinely submit blind and double blind samples to evaluate the laboratory's performance. If a report is issued to the laboratory, it is handled in the same manner as a scheduled PT study evaluation and follow-up.

12 CORRECTIVE AND PREVENTATIVE ACTION

12.1 Laboratory Investigation and Corrective Actions

Due to the technical nature of laboratory work and the broad scope of our QA program, a wide variety of laboratory issues can require investigation, root cause analysis, documentation, and corrective action. Prompt investigation and implementation of corrective action ensure that only data of known quality are reported and prevent the recurrence of errors. The following list provides "examples" of the type of issues that warrant investigation:

- Noncompliant QC results*
- Failed PT samples
- Reporting incorrect results
- Contamination issues
- Client technical complaints
- Procedural errors
- Missed holding times
- Systematic problems that compromise the accuracy or compliance of the data generated
- Problems with instrumentation and equipment which could compromise the data generated

These investigations must include the following:

- Identification of the problem
- Steps taken to investigate the problem
- Explanation of probable root cause(s) of the problem
- Steps taken to prevent future occurrence

- Determination of samples or systems affected by the problem

*Note: individual QC noncompliance does not require in depth investigation. Actions are taken as defined in the corresponding method and documented in the data. An adverse trend with noncompliance would be investigated.

Management is informed of problem situations. The QA staff track documentation, the status of the investigation activities, evaluates investigations for completeness and appropriateness, and monitors corrective action for follow-up/closure. Technical management and/or QA may issue a stop work notice if issues indicate the potential for problems on a broad scale or present a critical concern regarding the validity of the laboratory methods. The goal is to identify root cause, have the corrective action implemented promptly, and to the degree appropriate for the magnitude and risk of the problem. Tracking and trending of laboratory issues is performed by QA staff and reported to management on a monthly basis or immediately upon detection of a trend with potential for putting the laboratory or our clients at risk.

12.2 Investigation Process

All results from quality control (QC) samples are logged into the LIMS quality control system, which is programmed to alert analysts to unacceptable results. Analysts are required to review the results and determine the source of the problem. The source of the problem and proposed corrective action must be documented. Corrective action may include, but is not limited to, re-analysis, re-extraction or re-digestion, instrument maintenance, or re-calibration. If these actions do not yield compliant data within the required hold time, a Nonconformance Form is initiated to document actions and communication with the client. The original form is archived with the associated raw data. Nonconformance Forms are reviewed by the technical department's management, or designee. A copy of the form is reviewed by QA.

Missed holding times are investigated and documented using a Missed Holding Time form. The form includes documentation of the affected samples, reason the hold was missed and corrective actions taken, if applicable. Each form also has documented review and approval by the department manager, department director and the QA Director. Clients are informed of any problems involving holding time.

Other types of problems having potential impact on data quality or involve deviations to our processes are investigated and documented using an Investigation and Corrective Action Report (ICAR). This process was developed to ensure that laboratory problems are investigated, evaluated for root cause, corrective action is put into place to prevent recurrence, laboratory management review and QA approval occurs, and all steps are documented. These investigations are initiated and managed through a workflow interface (Jira). Any employee can initiate an ICAR through this system to document a laboratory problem. The investigation must be completed by designated members of management and approved/closed by QA. Each investigation has a unique tracking number assigned by Jira. Closed investigations are routed to the laboratory Vice-President, associated laboratory Director and the QA Director. Follow-up to ensure effective corrective action is managed by QA staff.

If a laboratory error is identified from the outcome of the investigation that impacts validity of client data, the client must be immediately notified in writing of the situation and corrected data provided as soon as possible. If the root cause of the problem has affected any other client sample results, all affected clients are notified immediately of the problem.

12.3 Client Feedback

The laboratory is in the business of providing high quality analytical testing services. The data that we supply to our clients must be technically complete, accurate, and compliant with applicable regulations. Complaints can be received via letter, phone call, e-mail, or face-to-face meeting.

When a complaint is received, it is our responsibility to determine, to the best of our ability, the extent of the issue and what data is in question. The person receiving the complaint documents this information and promptly forwards it to the appropriate management personnel where the work in question was performed. If a data reporting error is discovered, the final report and/or data must be regenerated with the correct value(s).

The CSR is responsible for entering client concerns into the LIMS and an automated summary report is sent to QA on a weekly basis for review. In some cases, an ICAR is initiated to address and document the situation. While an individual issue may not warrant a formal investigation, QA monitors these issues for potential trends and will issue an ICAR if a trend is evident.

On an annual basis, the laboratory sends a client satisfaction survey to all clients. The results of these surveys are compiled, routed to the laboratory Vice-President, technical and operations directors and the QA Director, and used to identify areas of improvement for the laboratory.

12.4 Preventative Actions

All employees are empowered and encouraged to use the concept of Preventive Action to avoid a problematic situation. The company supports, embraces and drives the process for continuous quality improvement by several means, such as: Ethics Hotline, the Suggestion Box (accessible to all employees on the company's Intranet 'LabLinks'), and training classes that include "Making Quality a Science" and Ethics. If an employee identifies a potential problem or an area of concern or it should be brought to the attention of his/her supervisor, Human Resources, QA Director or the Ethics Hotline.

The laboratory also utilizes a formal program to encourage preventive action through development of lean processes. The goal of this program is to optimize processes to ensure efficiency and operational improvements while maintaining compliance. The efficiency gains are inherently coupled with minimizing errors and rework. Teams of employees learn the tools and techniques to evaluate a process, identify potential sources of errors, delays or problems in an operation, determine system changes that will minimize these and work to implement the improvements. Each project includes thorough documentation of the evaluation, measurement, and implementation phases. The process is continually monitored to ensure that the anticipated results are sustained.

Employees are also encouraged to communicate to their supervisor any area(s) or operation(s) that they believe could be streamlined, make their job easier, would provide a quality improvement, or could provide a cost savings to the company.

Described below are some of the systems available to employees to assist with building quality and efficiency into their daily jobs. They stress a proactive approach/environment to problem solving and to review quality systems and operational efficiencies.

- "Making Quality a Science" is an introductory total quality management (TQM) course required for all employees to teach why quality is important and to explain the laboratory's quality philosophy and processes, and how to apply quality thinking and techniques on the job. Topics discussed include: communication, teamwork, serving the client, measurement, quality tools, and continuous process improvement. To foster continuous improvements of laboratory systems, process improvement teams are formed, as needed, if an employee needs help in solving a problem or addressing an issue. The goal of these groups is to have representation from various areas of the laboratory work together to look at a problem, evaluate the need for a temporary fix, brainstorm root

causes, plan process improvement, implement the process improvement, evaluate and follow-up to the corrective action.

- "Putting our Values to Work" (Ethics) is a seminar required for all employees to teach the laboratory's Statement of Values by examining how it translates to our everyday jobs and ethical decision making. Topics discussed include: Statement of Values, ethical paradigms, and ethical decision making. Mandatory ethics training refresher seminars are offered on an annual basis.

- The laboratory has contracted with an Ethics Hotline to provide an anonymous means of reporting ethics concerns or issues. The issue is forwarded by the service to the QA Director who will communicate internally with those who need to address the issue. All communication and actions are documented in a secure web interface managed by the hotline service company.

- The QA staff prepares monthly program status reports for management. The reports include a variety of metrics and graphs which are used to evaluate trends in laboratory performance across all quality and compliance areas. Management responds to any negative trends by developing a corrective action plan.

- The laboratory uses a Project Cycle process (further described in section 13.2) to proactively review and prepare for client projects in an effort to ensure full understanding by all laboratory staff of the client's needs and resolve any concerns in advance of receiving the work.

13 SERVICE TO CLIENTS

13.1 Service to Clients

We value our client relationships and support these partnerships through the following principles:

- Honesty and Fairness – Our corporate culture is founded on the principles of professionalism and high ethical standards in dealing with our clients. This may mean declining to provide the service requested (if we are convinced that to do so would be meaningless) or it may mean referring clients outside of our laboratory if we believe that another company can better meet their needs.

- Complete Service – We will give our clients full value on every service provided. We will provide detailed information on our methods, procedures, and QA programs if requested, and take a personal interest and initiative in helping solve our client's problems within the area of our professional expertise.

- Trustworthiness – All data and information developed for a client will be held confidential and not disclosed to a third party except on written request of the client. If information is subpoenaed, we must, by law, release it, but the client will be informed of the release.

- Commitment to Quality – We constantly strive to improve our service in quality, flexibility, and dependability, to keep our competitive edge. We will achieve this through: meeting the requirements of those we serve, staying apprised of regulatory and industry expectations, and providing prompt responses to client concerns.

- Basics of Superlative Service – Our focus is on our client's success. Through proactive collaborative communication, our leadership ensures we understand our client's expectations and strives to exceed them. We foster a service culture in our training, reward and recognition, and performance management process so each employee takes ownership to deliver superlative service to our clients. Feedback from clients, whether positive or negative, is an important part of our continuous improvement system. Ways in which feedback is gathered can include, but is not limited to, customer satisfaction surveys, client audits, and the customer complaint system, which is described within section 12.3.

We also view our fellow employees as our clients since they frequently receive the results of our labor. Meeting the requirements of the next employee in the workflow process is just as important as meeting the needs of an external client.

13.2 Review of Work Requests, Tenders, and Contracts

The laboratory places great importance on understanding and meeting client requirements for a project. We ensure, to the best of our ability, that client/project requirements are identified and communicated through the laboratory. Project evaluation can be achieved in various ways, including the review of analytical methods, protocols, business contracts, and quality project plans (QAPPs). The project review encompasses our Project Cycle process and individual topics to be evaluated for a project include, but are not limited to: scope of testing; required accreditations (i.e. individual state agencies, NELAP, DoD, and ISO 17025) held by the laboratory; appropriate and current testing methods; ability to meet project required reporting limits and QC (if applicable); inconsistencies clarified; and nonstandard work requests.

Project kick-off meetings can be arranged through the CSR or Business Development Group. These meetings allow the client and key technical personnel to discuss project issues and requirements prior to project initiation. Any differences between laboratory processes and the project requirements are discussed and addressed with the client and the laboratory staff before the project is accepted and samples arrive. Testing that cannot be performed at the laboratory may be subcontracted to another laboratory (see 13.4).

A key client contact, the CSR, is assigned to oversee the project. Communication between the client and laboratory staff is available and is coordinated through the CSR.

As a project continues, the CSRs provide continuous communication and status reports (if requested) about the project to the client. The CSR relays any project changes or modifications to the technical groups. If the client submits revised project documents (QAPPs, etc.) then the Project Cycle review process is repeated. The CSR also communicates any issues encountered by the technical laboratories back to the client and vice-versa.

13.3 Timely Delivery

Evaluating laboratory capacity and ability to perform specific projects is a joint responsibility between the Technical Director, Business Development, and the laboratory managers. We recognize that one of the most important aspects of the service we offer is turnaround time.

Many analysts are cross-trained to perform a variety of tests, and there is redundant equipment available in the laboratory area creating operation flexibility for routine work. Larger projects are reviewed against capacity estimates before bids are submitted to ensure that the client's schedule is met. Turnaround time is continually measured.

Regularly scheduled meetings are held with technical and support management, and project management personnel to review progress with current projects, as well as special requirements of new work scheduled for the laboratory.

Management receives a daily report of the status of all samples in the lab, including those with priority status or those that have exceeded a preset turnaround time. This enables the planning and organizing of the workload through efficient scheduling.

Any changes to the established timeline by the client or the laboratory must be communicated to the client or laboratory as soon as possible. Upon communication of changes, a new timeline is established and agreed upon by both parties. If a client requires a change in the scope of the project (e.g., number of samples submitted, change in analyses, revised protocol) the laboratory must be informed in writing and a new timeline and cost estimate is be provided.

13.4 Subcontracting

The laboratory may subcontract tests to other laboratories if the requested testing is not routinely performed in our laboratory. To a lesser extent, samples may need to be subcontracted to an overflow laboratory to ensure hold times and/or turn-around-times (TAT) are met.

Testing is only subcontracted with the client's knowledge and approval. The CSR must notify the client in writing when any of their requested analyses will be subcontracted to another lab. Client approval must be obtained in writing before samples are shipped.

Subcontract laboratories are selected based on their qualifications and accreditations. The subcontractor is requested to sign a Laboratory Analytical Services Subcontract. See form 9033100 to review details of the contract terms and information requested from the subcontract laboratory. If projects require a specific agency certification (i.e. individual state agencies, National Environmental Laboratory Accreditation Program (NELAP), Department of Defense (DoD) Environmental Laboratory Accreditation Program (ELAP), and ISO 17025), only an appropriately accredited laboratory is used. The client may also have a list of laboratories to be used for subcontracting. In these cases, the evaluation of the subcontract laboratory is made by the client.

Data obtained from subcontract laboratories is clearly marked as such when reported by the laboratory. The data are submitted to the client in the format obtained from the subcontractor.

13.5 Use of NELAP and A2LA Logo

It is not laboratory policy to use these logos on any company letterhead, including analytical reports.

End of document

Version history

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October 25, 2016

Analysis summary for Per- and Polyfluoroalkylsubstances at Eurofins Lancaster Laboratories Environmental (ELLE)

A. Extraction
   1. An aliquot of the water sample is spiked with isotopically labeled analogs of each of the native PFAS compounds for which an isotopically labeled analog is available. The sample is extracted using an SPE cartridge and target analytes are eluted with organic solvent. The solvent eluant is concentrated prior to instrumental analysis.
   2. A portion of the solid sample is spiked with isotopically labeled standards and is blended into a water/solvent dispersion and sonicated. The mixture is centrifuged and concentrated prior to instrumental analysis.

B. Analysis

   Extracts are analyzed by LC/MS/MS under a minimum 5 point calibration. The 5 point calibration standard solutions range from 0.2 ng/ml to 160 ng/ml depending on the specific target compound. Batch QC (MB, LCS, MS/MSD) are analyzed along with samples and continuing calibration standards.

C. Data

   Analysts are instructed to look for and include the branched chain isomers in the quantification of field samples for PFOA and PFOS (PFHxS as well). Calibration standards use the linear isomer of these compounds so that we have a known and predictable response as well as chromatographic retention time expectation. Then in field samples we are looking for a peak with the correct mass transitions at the retention time for the linear isomer. In addition, we then look for a peak or peaks that are eluting just prior to the linear peak, which would be the branched chain isomers. The areas of the branched and linear isomers are integrated together and quantified against the linear calibration standard to generate our final result.

   We analyze technical grade standards of PFOA, PFOS and PFHxS on each instrument with each initial calibration so that we have a qualitative indication of where the branched chain isomers are eluting relative to the linear isomer.

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PFAS Field Collection Considerations

Because PFASs can be found in a number of consumer products, several recommended practices that are listed below should be followed during the collection of samples to avoid potential cross contamination:

- Post-it Notes, markers/Sharpies®, waterproof field books, plastic clipboards should not be used (masonite or aluminum clipboards are recommended), binders, spiral hard cover notebooks, or glue materials should not be used at any time during sample handling, or field activity.
- All samples should be collected in high density polyethylene plastic (HDPE) bottles with an unlined cap that is Teflon™ free.
- The field personnel involved with sample collection and handling should avoid wearing new clothing (i.e., at least 6 washings with PFAS-free detergent since purchase). as well as Gore-Tex products and Tyvek suits and fabric softeners.
- Personnel collecting samples should not wear anti-stain and/or water resistant clothing or shoes immediately prior to or during sample collection. Rain gear made from polyurethane and wax-coated material is recommended.
- Personnel collecting and handling samples should wear nitrile gloves at all times while collecting and handling samples. Gloves should be changed frequently during sampling collection and handling.
- Sunblock/insect repellents used on site should consist of 100% natural ingredients and should be PFAS-free.
- Sample collectors should not use cosmetics, moisturizers, hand cream, or other related products.
- Many food and snack products are packaged in wrappers treated with PFASs. Therefore, hands should be thoroughly washed after handling fast food, carryout food, or snacks.
- No food or drink should be brought on site, with the exception of bottled water and hydration drinks.
- Blue Ice® should not be used to cool samples or be used in sample coolers.
- The use of decontamination soaps containing fluoro-surfactants such as Decon 90 must be avoided. Alconox® or Liquinox® is recommended.

We provide plastic (polyethylene) bottle ware to our clients and qualify all sample bottles to ensure they are PFAS-free. The lids on the bottles do not have Teflon™ lining. We have specially cleaned and tested PFAS-free deionized water that we use for all aspects of the PFAS extraction and analysis. We provide this water to clients for their field and equipment blanks. We have a separate lab space for the extraction and analysis of samples for PFAS analysis as well as the cleaning of glassware.

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PROPRIETARY CONTENT

Reference

1. US EPA Method 537 — Determination of Selected Perfluorinated Alkyl Acids in Drinking Water by Solid Phase Extraction and Liquid Chromatography/Tandem Mass Spectrometry (LCMSMS), Version 1.1, Modified, September 2009.

2. Determination of Selected Perfluorinated Alkyl Acids in Drinking Water by Solid Phase Extraction and Liquid Chromatography/Tandem Mass Spectrometry (LCMSMS), EPA 537 Version 1.1, Modified, September 2009. Department of Defense Quality System Manual Version 5.1, Table B-15.

3. Standard Test Method for Determination of Perfluorinated Compounds in Soil by Liquid Chromatography Tandem Mass Spectrometry (LC/MS/MS), ASTM Method D7968, 2014.

4. ISO 25101:2009(E) Water quality — Determination of perfluorooctanesulfonate (PFOS) and perfluorooctanoate (PFOA) — Method for unfiltered samples using solid phase extraction and liquid chromatography/mass spectrometry. March 2009.

5. Method for Trace Level Analysis of C8, C9, C10, C11, and C13 Perfluorocarbon Carboxylic Acids in Water. Karen Risha, John Flaherty, Roice Wille, Warren Buck, Francesco Morandi, and Tsuguhide Isemura. Anal. Chem. 2005, 77, 1503-1508.

6. *Chemical Hygiene Plan*, current version.

Cross Reference

Document	Document Title
T-PEST-WI9847	Common Equations Used During Chromatographic Analyses
T-PFAS-WI13881	Standards Management in the PFAS Laboratory

Scope

This method is applicable for the determination of selected per- and polyfluorinated alkyl substances (PFAS) in aqueous samples to include non-potable waters and non-regulatory potable water when directed by the client. The compounds analyzed in this method are listed in the table below. The most current MDLs and LOQs are listed in the LIMS.

Analyte	Acronym	CAS#
Perfluorobutanesulfonic acid	PFBS	375-73-5
Perfluorodecanoic acid	PFDA	335-76-2
Perfluorododecanoic acid	PFDoDA	307-55-1
Perfluoroheptanoic acid	PFHpA	375-85-9
Perfluorohexanesulfonic acid	PFHxS	355-46-4
Perfluorohexanoic acid	PFHxA	307-24-4
Perfluorononanoic acid	PFNA	375-95-1
Perfluorooctanesulfonic acid	PFOS	1763-23-1
Perfluorooctanoic acid	PFOA	335-67-1
Perfluorotetradecanoic acid	PFTeDA	376-06-7
Perfluorotridecanoic acid	PFTrDA	72629-94-8
Perfluoroundecanoic acid	PFUnDA	2058-94-8
Perfluoro-n-butanoic acid	PFBA	375-22-4
Perfluoro-n-pentanoic acid	PFPeA	2706-90-3
8:2 - Fluorotelomersulfonate	8:2FTS	39108-34-4
N-methylperfluoro-1-octanesulfonamidoacetic acid	NMeFOSAA	2355-31-9
N-ethylperfluoro-1-octanesulfonamidoacetic acid Perfluoroundecanoic acid	NEtFOSAA	2991-50-6
4:2-Fluorotelomersulfonate	4:2-FTS	757124-72-4
Perfluoropentanesulfonate	PFPeS	2706-94-4
6:2-Fluorotelomersulfonate	6:2-FTS	27619-97-2

Perfluoroheptanesulfonate	PFHpS	375-92-8
Perfluorononanesulfonate	PFNS	474511-07-4
Perfluorodecanesulfonate	PFDS	335-77-3
10:2-Fluorotelomersulfonate	10:2-FTS	120226-60-0
Perfluorododecanesulfonate	PFDoDS	79780-39-5
Perfluorohexadecanoic acid	PFHxDA	67905-19-5
Perfluorooctadecanoic acid	PFODA	16517-17-6
Perfluorooctanesulfonamide	PFOSA	754-91-6
2-(N-methylperfluoro-1-octanesulfonamido)-ethanol	NMePFOSAE	24448-09-7
N-methylperfluoro-1-octanesulfonamide	NMePFOSA	31506-32-8
2-(N-ethylperfluoro-1-octanesulfonamido)-ethanol	NEtPFOSAE	1691-99-2
N-ethylperfluoro-1-octanesulfonamide	NEtPFOSA	4151-50-2

Basic Principles

A 250-mL aqueous sample is fortified with isotopically-labeled extraction standards and is passed through a solid phase extraction (SPE) cartridge to extract the analytes. The compounds are eluted from the solid phase with a combination of solvents. The extract is concentrated to ~400-500ul with nitrogen in a heated water bath, and then reconstituted to 1ml with methanol. Isotopically-labeled injection internal standards are added to the sample extract and it is analyzed by LC/MS/MS operated in negative electrospray ionization (ESI) mode for detection and quantification of the analytes. Quantitative analysis is performed using isotope dilution.

Reference Modifications

EPA Method 537 is written specifically for the analysis of drinking water samples. The following modifications to the method have been made to accommodate all aqueous samples.

1. A labeled isotopic analog is spiked into samples for all compounds where an isotopic analog is commercially available. These isotopic compounds are referred to as extraction standards. For those compounds, an isotope dilution calibration model is used. Where labeled isotopes are not available, an internal standard calibration model using the extraction standards is used.
2. Prior to instrumental analysis, separate but similar isotopic analogs are added to the sample extract prior to instrumental analysis. Using an internal standard calibration model these injection standards are used to calculate recoveries of the extraction standards..
3. Field reagent blanks are not processed as listed in EPA 537 Version 1.1 section 8.3

4. Trizma is not used for waters except in the cases where the water comes from a chlorinated water source.
5. Branched isomers of PFOS, PFHxS, NetFOSAA and NMeFOSAA are not included in the calibration curves.
6. Peak asymmetry factors are not calculated.
7. MRL confirmation is not performed.
8. Spike concentrations are not rotated between low, medium and high levels.
9. SPE is used for sample preparation. Cartridge types and elution profiles differ from EPA 537 Version 1.1

MDL studies and IDOCs have been performed to validate method performance.

Interferences
Compounds which have similar structures to the compounds of interest and similar molecular weights would potentially interfere. Method interferences may be caused by contaminants in solvents, reagents (including reagent water), sample bottles and caps, and other sample processing hardware that lead to discrete artifacts and/or elevated baselines in the chromatograms. The analytes in this method can also be found in many common laboratory supplies and equipment, such as PTFE (polytetrafluoroethylene) products, LC solvent lines, methanol, aluminum foil, etc. A laboratory blank is performed with each batch of samples to demonstrate that the extraction system is free of contaminants.

Precaution to Minimize Method Interference

PROPRIETARY CONTENT

Safety Precautions and Waste Handling
See *Chemical Hygiene Plan* for general information regarding employee safety, waste management, and pollution prevention.

The toxicity or carcinogenicity of each reagent used in this method has not been precisely defined. PFOA has been described as “likely to be carcinogenic to humans”. Each chemical should be treated as a potential health hazard and exposure to these chemicals should be minimized.

Exposure to these chemicals must be reduced to the lowest possible level by whatever means available, such as fume hoods, lab coats, safety glasses, and gloves. Gloves, lab coats, and safety glasses should be worn when preparing standards and handling samples. Avoid inhaling solvents and chemicals and getting them on the skin. Wear gloves when handling neat materials. When working with acids and bases, take care not to come in contact and to wipe any spills. Always add acid to water when preparing reagents containing concentrated acids.

All laboratory waste is accumulated, managed, and disposed of in accordance with all Federal, State, and local laws and regulations. All solvent waste and extracts are collected in approved solvent waste containers in the laboratory and subsequently emptied by personnel trained in hazardous waste disposal into the lab-wide disposal facility. HPLC vials are disposed of in the lab container for waste vials, and subsequently lab packed. Any solid waste material (disposable pipettes and broken glassware, etc.) may be disposed of in the normal solid waste collection containers.

Personnel Training and Qualifications

All personnel performing this procedure must have documentation of reading, understanding, and agreeing to follow the current version of this SOP and an annual documented Demonstration of Capability (DOC).

Initially, each chemist performing the extraction must work with an experienced employee for a period of time until they can independently perform the extraction. Also, several batches of sample extractions must be performed under the direct observation of another experienced chemist to assure the trainee is capable of independent preparation. During the training period, the new chemist may also learn the operation of the LC/MS/MS, calibration techniques, data processing and review, and maintenance procedures. Proficiency is measured through a documented Initial Demonstration of Capability (IDOC)

The IDOC and DOC consist of four laboratory control samples (or alternatively, one blind sample for the DOC) that is carried through all steps of the extraction and meets the defined acceptance criteria. The criteria include the calculation of mean accuracy and standard deviation.

Sample Collection, Preservation, and Handling

A. Sample Collection

The samples are collected in 250 mL polyethylene bottles containing 1.25 grams of Trizma, resulting in a Trizma concentration in the sample of 5 g/L. Trizma functions as a free chlorine scavenger; therefore, any chlorinated water supplies require the preservative. Water samples from non-chlorinated water sources would not necessarily require the Trizma preservative. Keep the sample sealed from time of collection until extraction.

NOTE: PFAS contamination during sampling can occur from a number of common sources, such as food packaging and certain foods and beverages. Proper hand washing and wearing nitrile gloves will aid in minimizing this type of accidental contamination of the samples.

B. Sample Storage and Shipment

1. Samples must be chilled during shipment and must not exceed 10°C during the first 48 hours after collection. Sample temperature must be confirmed to be at or below 10°C when the samples are received at the laboratory.

2. Samples stored in the lab must be held at a temperature of 0° to 6°C, not frozen, until extraction.

3. Water samples must be extracted within 14 days. Extracts must be analyzed

within 28 days after extraction. Extracts are stored at room temperature.

Apparatus and Equipment

PROPRIETARY CONTENT – LC/MS/MS that functions in ESI negative ION mode.

Reagents and Standards
All solvents, acids, and bases are stored in glass bottles in flammable proof cabinets or pressure resistant steel drums. Solvents, acids, and bases are stored at ambient temperature for up to 1 year. All non-solvents are stored according to manufacturer's storage conditions.

A. Reagents:

PROPRIETARY CONTENT

B. Standards: See SOP T-PFAS-WI13881

Calibration
A. Initial Calibration

1. A minimum of five calibration standards are required. In general, Cal1, Cal2, Cal3, Cal4, Cal5, Cal6, and Cal 7 are included in the initial calibration. S/N ratio must be ≥ 10:1 for all ions used for quantification.

2. Initially an MDL standard is analyzed to ensure all compounds can be detected at the MDL level. Following the MDL standard, the Cal1-Cal7calibration standards are analyzed. If compounds are not detected in the MDL standard, the source of the problem must be determined and the MDL standard reanalyzed.

3. Analyze a Cal3 level standard that contains linear and branch chained isomers of PFOA, PFOS and PFHxS. The analysis of this standard is used to demonstrate where the branch chained isomers elute and not included in the calibration curve. This will assist the chemist in identifying and properly integrating these compounds in samples.

4. Fit the curve with a linear through zero or linear with a concentration weighing factor of 1/x or quadratic regression with a concentration weighing factor $1/x^2$.

5. Isotopically labeled compounds are not available for PFPeS, PFHpS, PFNS, PFDS, PFDoS, 10:2-FTS, PFTrA, PFHxDA, and PFODA. See below for referenced extraction standards.

Compound	Extraction standard
PFPeS	13C3-PFBS
PFHpS	13C3-PFHxS
PFNS	13C8-PFOS
PFDS	13C8-PFOS
PFDoS	13C8-PFOS
10:2-FTS	13C2-8:2-FTS
PFTrDA	13C2-PFDoDA
PFHxDA	13C2-PFTeDA
PFODA	13C2-PFTeDA

6. Initial calibration acceptance criteria

When each calibration point, except the lowest point (Cal1), is calculated back against the curve, the back calculated concentration should be within ±70-130% of its true value. The lowest calibration point (Cal1) should calculate to be within ±50-150% of its true value. The R^2 value for each calibration curve must be ≥ 0.99 for each analyte.

DoD QSM5.1 criteria:

a. All calibration points must be within ±70-130% of their true values.

b. The %RSD of the response factors for all analytes must be < 20%.

If the criteria are not met, the source of the problem must be determined and corrected. Situations may exist where the initial calibration can be used. In those cases, the data will be reported with a qualifying comment.

7. Initial Calibration Verification (ICV)

A check standard prepared from a second source (ICV) is injected to confirm the validity of the calibration curve/standard. The calculated amount for each analyte should be ± 30% of the true value.

B. Continuing calibration

1. Once the calibration curve has been established, the continuing accuracy must be verified by analysis of a continuing calibration verification (CCV) standard every ten samples and at the end of the analysis sequence.

a. The CCV run after the initial calibration must be at the CAL3 level.

b. Subsequent CCV standards should alternate between the low, mid and high levels of the calibration curve.

DoD QSM5.1 criteria: The CCV standards must alternate between the CAL1-CAL3 levels. All analyte concentrations must be within ±30% of their true values.

2. Acceptance criteria

a. The calculated amount for each compound (native and extraction standard) in the CCV standard must be within ±30% of the true value. Samples that are not bracketed by acceptable CCV analyses must be reanalyzed. The exception to this would be if the CCV recoveries are high, indicating increased sensitivity, and there are no positive detections in the associated samples, the data may be reported with a qualifying comment.

DoD QSM5.1 criteria: If acceptance criteria are not met, immediately analyze two additional consecutive CCVs. If both pass acceptance criteria, samples may be reported without reanalysis. If either fail, or two consecutive CCVs cannot be run, repeat CCV and reanalyze all samples since last successful CCV.

b. The absolute areas of the injection internal standards should be within 50-150% of the average areas measured during the initial calibration.

Procedure

A. Sample Preparation - **all samples**

1. Mark the outside of each sample container with pen ("Sharpie") to record the level of the sample in the container prior to extraction.

2. If required, add 1.25 grams of Trizma to a 250 ml HDPE bottle for the laboratory reagent blank (LRB) and the lab fortified blank (LFB). Fill each bottle with 250 ml of Milli-Q water. Record 250 ml as the volume for the batch QC samples on the batchlog.

3. If sample has dissolved and/or settleable solid content; i.e., is cloudy or has a layer of sediment/solids at the bottom of the bottle, an aliquot should be taken from the original bottle and diluted with reagent water in order to minimize difficulty passing through the SPE sorbent bed. If unsure whether or not less-than-full sample volume should be used for SPE extraction, consult a supervisor.

a. Determine aliquot to be used for extraction (50ml; 100ml).

b. Label a clean 250ml HDPE bottle with associated ELLE sample number.

c. Label appropriate number of 50ml centrifuge tubes.

d. Shake/invert sample bottle to thoroughly mix the sample before pouring aliquot(s).

e. Pour sample from original bottle into centrifuge tubes. Cap tubes and centrifuge for 5 minutes at full speed (one full cycle).

f. On a calibrated, top-loading balance, place labeled empty 250ml PP wide-mouthed bottle.

g. Decant centrifuged sample aliquot(s) from centrifuge tube(s) to the 250ml bottle until desired volume (weight in grams) is reached. 100g = 100ml; 50g = 50ml, etc.

h. Add Milli-Q water to the bottle until a weight of 250g (total of 250ml) is reached.

i. Shake/invert several times to mix thoroughly.

j. Record the aliquot taken from the original bottle (50ml; 100ml) as the sample volume.

B. Solid Phase Extraction (SPE) - **all samples**

PROPRIETARY CONTENT

15. Reconstitute to 1.0 ml with 100% methanol. Vortex to mix. Centrifuge all 15 ml collection tubes at for 5 minute at full speed (~4100 rpm).

16. Place each empty sample bottle on the top-loading balance and tare.

17. Fill each tared sample container to the mark placed on the bottle prior to extraction with DI water.

18. Record the weight as the sample volume on the batchlog.

19. Transfer 400 µL of the final extract to labeled auto-sampler vials. Add 20 ul of labeled internal standard spike and cap and vortex the auto-sampler vial. Samples are now ready for analysis.

20. Cap the centrifuge tube. Store the remaining centrifuged extracts at room temperature for dilution or reinjection if needed.

C. **Extract Treatment for DoD samples:**

PROPRIETARY CONTENT

D. Serial Dilution Sample Prep

PROPRIETARY CONTENT

E. LC/MS/MS Analysis

1. Mass Calibration and Tuning

a. At instrument set up and installation and after the performance of major maintenance, calibrate the mass scale of the MS with calibration compounds and procedures described by the manufacturer. The entire mass range must be calibrated.

b. When masses fall outside of the ±0.5 amu of the true value, the instrument must be retuned using PPG according to the manufacturer's specifications. Mass assignments of the tuning standard must be within 0.5 amu of the true value. Refer to the instrument manufacturer's instructions for tuning and conditions. These values are stored in the tune file for future reference.

2. The mass spectral acquisition rate must include a minimum of 10 spectra scans across each chromatographic peak.

3. Acquisition method: See attachment 1

4. DoD QSM5.1 criteria for Instrument Sensitivity Check (ISC) and Instrument Blanks

a. Prior to sample analysis and at least every 12 hours, an instrument sensitivity check (ISC) must be performed. The CAL1 standard will be analyzed. All analyte concentrations must be within +/- 30 of their true values. If the criteria is not met, correct problem and rerun ISC. If problem persists, repeat the ICAL. No samples can be analyzed until the ISC meets acceptance criteria.

b. Instrument blanks need to be analyzed immediately following the highest standard analyzed and daily or at the start of a sequence. The concentration of all analytes must be ≤ 1/2 the LOQ. If acceptance criteria are not met the calibration must be performed using a lower concentration standard for the high standard until the criteria are met.

5. Load sample vials containing standards, quality control samples, and sample extracts into autosampler tray. Allow the instrument adequate time to equilibrate to ensure the mass spec and LC have reached operating conditions (approximately 5 minutes) before the first injection. Analyze several solvent blanks clean the instrument prior to sample acquisition.

6. After the initial calibration, inject a solvent blank, followed by the ICV, L/B standard, closing Cal 3 level CCV , CCV, extraction batch QC, and samples. Bracket each set of ten samples with a CCV standard, alternating between the Cal3, Cal4, and Cal5 levels.

Note: For DoD QSM5.1: CCVs will range from the CAL1 to the CAL3 level standard.

7. After injections are completed, check all CCV recoveries and absolute areas to make sure they are within method control limits. See Calibration section B.2 for acceptance criteria. Process each chromatogram and closely evaluate all integrations, baseline anomalies, and retention time differences.

If manual integrations are performed, they must be documented and a reason given for the change in integrations. The manual integrations are documented during data processing and all original integrations are reported at the end of the sample PDF file with the reason for manual integration clearly listed.

8. Quantitate results for the extraction blank.

a. Non-DoD criteria: No target analytes at or above the reporting limit may be found in the extraction blank for acceptable batch results. If a target analyte is detected in the extraction blank but not detected in the sample, the data is reported. If a target analyte is detected in the method blank at a concentration greater than the reporting limit and also in the sample, the sample must be reextracted. If the target analyte in the sample is detected at a concentration greater than 10 times the amount detected in the method blank, the data is reported.

b. DoD QSM5.1 criteria: No target analytes detected > 1/2 the LOQ or > 1/10 the regulatory limit, whichever is greater. If criteria is exceeded, reextract all samples with positive detections associated with the method blank.

9. Calculate the recoveries of spiked analytes for the LCS, matrix spike and matrix spike duplicate (MS/MSD) by comparing concentrations observed to the true values. The advisory QC acceptance limits for LCS and MS/MSD recovery are 70 to 130% for each analyte. The advisory QC acceptance limit for the relative percent difference (%RPD) between LCS/LCSD and MS/MSD is ≤30%. If LCS and/or LCSD recoveries are acceptable, proceed to sample quantitation. If the LCS recoveries are unacceptable, the samples associated with the LCS may need to be reanalyzed. If LCS recoveries are above the advisory QC acceptance limits, and there are no positive detections in the sample, the data may be reported. If MS/MSD recoveries are outside QC acceptance criteria, the associated data will be flagged or noted in the comments section of the report.

10. Isotopically labeled extraction standards are added to all samples, extraction blank, LCS/LCSD, and MS/MSD prior to extraction.

a. Non-DoD criteria: The recovery of the extraction standards should be within QC acceptance criteria. If the extraction standard recovery(ies) is(are) outside the QC limit(s), consult a supervisor to determine the appropriate course of action based on batch and sample results.

b. DoD QSM5.1 criteria: All extraction standard recoveries must be within 50% to 150% of the true value. If recoveries are outside the acceptance criteria, samples must be reextracted.

11. Isotopically labeled injection standards are added to each QC and field sample extract prior to analysis.

a. Non-DoD criteria: The absolute areas of the injection standards should be within 50-150% of the average areas measured during the initial calibration. If the internal standards are recovered outside 50-150%, consult a supervisor to determine the appropriate course of action based on batch and sample results.

b. DoD QSM5.1 criteria: Peak areas must be within -50% to +50% of the area measured in the ICAL midpoint standard. On days when an ICAL is not performed, the peak areas must be within -50% to +50% of the peak area measured in the daily initial CCV. If injection internal standards fall outside the acceptance window, analyze a second aliquot of the extract. If none remains, reanalyze the first aliquot.

12. Compare the retention times of all of the analytes, surrogates and internals standards. The relative retention times should not vary by more than 0.2 retention time units.

13. The MDL standard and the linear/branch chain standard are used when assessing the correctness of the computer generated peak integrations. For results that have responses at or near the MDL, the analysts will calculate 1/2 of the area ratio of that compound in the MDL standard. If the area ratio for the compound in the sample exceeds that 1/2 the area ratio from the MDL standard, the peak is reported as a positive detection.

14. If the calculated concentation exceeds the calibration range of the system, dilute the extract with MeOH and add the appropriate amount of extraction standard to match the original concentration. Add 10 ul of injection internal standard and analyze the dilution.

Dilution Example 1/10: Mix 0.877 mL of MEOH with 0.100 mL of sample extract and 0.0225 mL of labeled extraction standard. Vortex to mix. Using an auto-pipette, transfer 200 uL of the mixed solution into a labeled auto-sampler vial containing a plastic insert. Using a syringe, add 10 uL of labeled injection std to the 200 uL aliquot. Cap and vortex thoroughly to mix.

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Calculations

A. Peak Area Ratio

$$\text{Peak Area Ratio} = \frac{\text{Analyte Response}}{\text{Labeled Analyte Response}}$$

B. Analyte Concentration using linear through zero curves (MQ Data processing system)

Concentration = (area ratio ÷ slope) x Dilution Factor x Internal Standard concentration

Where: internal standard concentration = 1 ng/ml

C. Sample Concentration (used only for aqueous samples using the MultiQuant data processing system on the AB Sciex LC/MS/MS)

Sample concentration (ng/l) = Calc conc x (Sample volume ÷ Sample weight) x DF

D. See *T-PEST-WI9847* for additional calculations used to evaluate the calibrations and quality control samples.

Statistical Information/Method Performance

The method is evaluated through both initial and ongoing Demonstrations of Capability (IDOC and DOC). The IDOC includes performance of quad studies, MDL studies, and when available, acceptable scores obtained in Performance Testing (PT) studies. Annual MDL studies are performed as are annual analyst DOCs.

Quality Assurance/Quality Control

For each batch of samples extracted, a method blank, an LCS/LCSD (Milli Q water spiked with all compounds to be determined carried through the entire procedure), and an MS must be extracted. If an MSD is submitted then an LCSD would not be extracted. A batch is defined as the samples to be extracted on any given day, but not to exceed 20 field samples. If more than 20 samples are prepared in a day, an additional batch must be prepared. If any client, state, or agency has more stringent QC or batching requirements, these must be followed instead. Statistical control limits must be calculated for recoveries of LCS and MS when sufficient data points have been collected

T-PEST-WI9847 Common Equations Used During Chromatographic Analyses T-PFAS-WI13881 Standards Management in the PFAS Laboratory

Attachment:
Attachment 1
Attachment 2

End of document

Version history

Version	Approval	Revision information
4	03.JAN.2018	
5	24.FEB.2018	
6	01.MAR.2018	

ATTACHMENT F

ACRONYMS AND ABBREVIATIONS USED IN TABLES, FIGURES, AND ATTACHMENTS

Attachment F
List of Acronyms and Abbreviations Used in Tables, Figures and Attachments
Army Creek Landfill Superfund Site
New Castle County, Delaware

Acronym/Abbreviation	Definition
% R	Percent Recovery
% O_2	Percent Oxygen
° C	degrees Celsius
ACL	Army Creek Landfill
ASAP	as soon as possible
AWC	Artesian Water Company
CRDL	Contract Required Detection Limit
CRQL	Contract Required Quantification Limit
DI	De-ionized
DS&G	Delaware Sand & Gravel
Fe	Iron
ft	feet
ft-bgs	feet below ground surface
ft-bmp	feet below measuring point
ft-btoc	feet below top of casing
gal	gallons
gal/ft	gallons per foot
GC/MS	Gas Chromatograph/Mass Spectrometer
gpm	gallons per minute
HAL	Health Advisory Level
HASP	Health and Safety Plan
HPDE	High Density Polyethylene
ICP MS	Inductively Coupled Plasma Mass Spectroscopy
IDL	Instrument Detection Limit
in	inch
LCS	Laboratory Control Sample
LDPE	Low-Density Polyethylene
LS	Lower Sand
MCAWW	Methods for Chemical Analysis of Water and Wastes
MCL	Maximum Contaminant Limit
MDL	Method Detection Limit
min	minute
mg/l	milligram per liter
ml	milliliter
ml/min	milliliter per minute
Mn	manganese
MPCU	Middle Potomac Confining Unit
MS	Matrix Spike
mS/cm	millisiemens per centimeter
MSD	Matrix Spike Duplicate
MSL	Mean Sea Level
mV	Millivolt
MW	Monitoring Well

Attachment F
List of Acronyms and Abbreviations Used in Tables, Figures and Attachments
Army Creek Landfill Superfund Site
New Castle County, Delaware

Acronym/Abbreviation	Definition
NA	Not Applicable
NCC	New Castle County
ng/l	nanograms per liter
NR	No Record
NTU	Nephelometric Turbidity Unit
PCBs	Polychlorinated Biphenyls
PDIWP	Pre-Design Investigation Work Plan
PFAs	Per-and poly-fluoroalkyl substances
PID	Photo-ionization Detector
ppm	parts per million
PVC	Polyvinyl Chloride
QA	Quality Assurance
QA/QC	Quality Assurance / Quality Control
QC	Quality Control
QL	Quantitation Limit
RCRA	Resource Conservation and Recovery Act
RPD	Relative Percent Difference
RSLs	Regional Screening Levels
SAP	Sampling and Analysis Plan
SIM	Selected Ion Monitoring
S/m	Siemens per meter
SMCL	Secondary Maximum Contaminant Limit
SOP	Standard Operating Procedures
std	Standard Unit (pH)
S.U.	Standard Unit (pH)
TAL	Target Analyte List
TCL	Target Compound List
TICs	Tentatively Identified Compounds
ug/l	Microgram Per Liter
UPA	Upper Potomac Aquifer
UPCU	Upper Potomac Confining Unit
UPCUTZ	Upper Potomac Confining Unit Transition Zone
UPDC	Upper Potomac Dividing Clay
US	Upper Sand
USEPA	United States Environmental Protection Agency
VOCs	Volatile Organic Compounds

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ATTACHMENT 5

SURFACE WATER, COLUMBIA AQUIFER AND VERTICAL GRADIENT ASSESSMENT

Attachment 5A

Summary of Water-Level Elevations for Pump-Out-Test Suspension Pilot Test
Activity of the Array Check Pue Delaware Sand & Gravel Facilities

	Pre-Suspension		Post-Suspension											
	04/12/80	08/12/80	11/08/04	01/12/02	05/22/02	09/11/02	10/14/02	02/05/03	04/12/03	06/10/03	08/06/03	10/08/03	12/03/03	01/05/04
Monitoring Recovery Wells														
WM-4	-23.15	-24.31	-26.91	-31.11	0.00	-28.9	-14.11	-14.0	-16.4	-0.8	-8.6	-9.9	-7.1	-8.6
DGC-16S	-18.82	-19.91	-13.32	-13.11	-9.4	-10.30	--	-9.4	-22.10	-18.31	-21.41	-13.00	-13.49	-21.31
DGC-16D	-17.55	-17.31	-12.52	-13.31	-36.31	-54.5	--	-36.31	-31.8	-31.31	-36.31	-31.11	-30.31	-30.41
DGC-11S	-18.31	-19.90	-30.50	-33.11	-13.31	-13.5	--	-13.31	-24.8	-24.41	-24.41	-24.41	-24.41	-13.31
DGC-11D	-14.41	-12.31	-26.54	-28.31	-20.81	-14.3	--	-26.53	-14.4	-28.11	-24.41	-44.31	-24.41	-28.41
WM-18	--	-12.31	-28.81	--	-38.0	-37.10	-31.41	-31.41	-31.4	-22.8	-30.11	-30.01	-14.8	-35.01
WM-22N	-12.55	-12.41	-33.50	-13.41	-13.3	-14.41	-14.31	-33.31	-33.3	-28.41	-28.31	-30.01	-30.01	-18.41
WM-28N	-12.32	-28.31	-28.12	-34.50	-13.4	-13.31	-14.81	-16.34	-31.4	-12.31	-22.50	-21.31	-21.41	-30.81
WM-5	-35.12	-28.31	-28.91	-29.31	-22.0	-12.2	-31.21	-30.1	-28.4	-28.8	-28.8	-18.8	-18.9	-30.2
WM-8	-30.02	-18.31	-29.31	-32.41	-52.41	-9.0	-29.3	-28.11	-31.21	-29.8	-28.8	-28.9	-28.9	-32.3
WM-6	-28.02	-28.81	-31.41	-29.8	-52.8	-11.1	-29.8	-14.0	-14.0	-31.4	-28.9	-28.4	-28.9	-32.3
WM-14	-30.06	-24.81	-32.31	-12.41	-52.8	-12.0	-32.0	-12.4	-20.0	-28.4	-28.9	-24.31	-24.31	-32.1
WM-24	-32.55	-12.81	-28.81	-34.31	-29.1	-12.1	-11.31	-11.81	-25.1	-25.31	-25.31	-12.31	-11.9	-30.11
WM-28N	-18.15	-14.81	-31.41	-52.41	-44.0	-32.01	-32.11	-32.8	-30.0	-12.1	-12.11	-32.01	-32.8	-32.01
WM-10	-14.32	-32.81	-31.41	-48.31	-12.0	-9.8	-33.1	-33.1	-28.1	-32.0	-32.11	-32.11	-31.1	-9.8
WM-11	-15.12	-28.81	-28.81	-31.11	-31.0	-14.1	-28.11	-28.1	-28.0	-28.4	-28.8	-28.8	-22.8	-34.1
WM-12	-32.81	-12.31	-32.41	-28.31	-31.0	-28.0	-28.8	-31.1	-32.3	-32.4	-28.9	-32.1	-11.2	-31.2
WM-18N	-32.45	-12.81	-28.81	-31.41	-28.8	-28.9	-14.8	-14.81	-28.1	-28.4	-21.81	-21.81	-24.81	-28.81
WM-26	-30.2	-14.7	-28.7	-28.1	31.2	14.3	1.0	36.2	36.8	36.8	1.0	14.1	36.8	11.3
WM-29	-14.00	-28.11	-8.8	-14.8	22.3	22.8	0.0	0.0	28.2	28.1	-12.0	32.5	22.0	14.0
WM-21	-30.11	-8.8	-32.5	-10.0	28.5	10.0	21.1	22.1	28.1	22.2	12.0	30.0	12.1	18.1
WM-25	-23.8	-20.8	-22.5	-28.5	28.2	0.41	-28.0	28.2	28.1	-29.0	-29.0	29.1	29.1	14.1
WM-30	-32.5	-12.81	-28.8	--	--	-28.8	-32.11	-23.1	-12.0	-28.1	-28.8	-32.8	-18.9	-28.8
WM-19	-12.15	-10.81	-20.41	-20.11	-12.0	-28.8	-30.21	-28.1	-34.2	-12.8	-12.8	-28.01	-14.2	-28.8
WM-20	-23.55	-12.81	-12.41	-10.41	-12.0	-28.8	-20.11	-28.0	-34.1	-12.2	-10.8	-12.1	-12.8	-28.9
WM-23	-20.00	-28.81	-28.81	-28.8	11.0	-28.2	-32.11	-28.0	-23.0	-14.8	-28.8	-20.8	-20.8	-28.2
WM-27	-20.50	-23.8	-23.8	-22.2	-28.5	-28.2	28.2	28.1	28.0	-28.0	28.0	28.1	28.1	28.1
WM-31	-28.81	-12.81	-28.81	-28.8	--	--	-28.8	-32.11	-23.1	-14.2	-28.8	-32.8	-18.9	-28.8
WM-17	-12.15	-10.81	-20.41	-20.41	-12.0	-28.8	-32.11	-20.1	-34.1	-12.8	-12.8	-28.01	-14.2	-28.8
WM-18	-32.55	-12.81	-12.41	-10.41	-12.0	-28.8	-20.11	-28.0	-34.2	-12.2	-10.8	-12.1	-12.8	-28.9
WM-19	-10.15	-28.81	-28.81	-28.8	11.0	-28.2	-32.11	-28.0	-23.0	-14.8	-28.8	-20.8	-20.8	-28.2
9-1	-10.15	-10.81	-28.81	-28.81	-23.0	-23.0	-32.11	-28.0	-28.0	-23.0	-23.0	-28.0	-28.0	-28.11
9-2	-32.55	-12.81	-28.81	-28.81	-28.81	-28.81	-32.11	-32.11	-28.0	-23.0	-23.0	-28.11	-28.11	-32.11
9-10	-30.55	-28.81	-28.81	-28.81	-12.1	-14.1	-28.11	-23.0	-28.0	-28.0	-28.11	-28.11	-21.8	-31.01
9-8	-30.50	-44.31	-12.31	-10.41	-12.0	-23.0	-28.8	-28.11	-36.1	-12.8	-24.1	-14.8	-10.8	-32.8
MW-1 (Druco)	-29.00	-20.00	-29.00	-12.00	-29.00	-29.00	--	-20.00	--	--	--	--	--	--
MW-3 (Druco)	-10.01	-32.1	-14.0	-34.8	-31.1	--	--	--	--	--	--	--	--	--
RT-10B	-13.11	-32.31	-28.81	-28.41	-33.1	-11.11	-32.81	--	-16.8	-16.8	-23.11	-23.11	-12.8	--
MW-1	-32.55	-16.81	-28.41	-14.81	-11.1	-12.8	-31.41	--	--	--	--	--	--	--
MW-10	-30.15	-22.31	-22.11	-30.11	-12.0	-28.8	-30.11	-30.0	-28.4	-12.8	-28.8	-28.8	-30.8	-30.2
MW-11R	-32.50	-32.41	-32.81	-30.50	30.0	-32.8	-30.31	-14.0	-3.0	-3.2	-32.8	-32.8	-32.8	-32.8
MW-12	-32.55	-31.81	-31.81	-32.3	32.3	-31.4	-31.4	-32.8	-23.0	-22.8	-22.8	-22.8	-22.8	-32.8
MW-18	-32.81	-32.31	-32.31	-32.3	32.3	32.8	-32.8	-32.11	-32.3	32.3	32.3	32.3	32.3	32.3
MW-7	-32.11	-12.8	-12.8	-32.11	-11.1	-31.1	--	--	--	--	--	--	--	--
8-8	31.12	30.12	30.12	31.12	31.12	31.12	31.22	30.02	31.12	31.12	30.22	30.12	30.12	31.02
MW-1	-32.55	-31.81	-32.55	--	-32.5	-32.41	-31.11	-33.31	-32.5	-32.8	-31.41	-32.41	-31.41	-31.41
MW-2	-32.52	-28.81	-28.41	-30.00	-28.41	-32.5	-31.21	-30.31	-32.0	-28.8	-31.11	-32.41	-32.41	-32.41
MW-3	-14.55	-28.81	-28.41	-32.41	-28.41	-32.5	-31.21	-30.31	-32.0	-28.8	-31.11	-32.41	-32.41	-32.41
MW-4	-32.55	-32.41	-32.41	-28.41	-28.41	-32.5	-31.21	-30.31	-32.0	-28.8	-31.11	-32.41	-32.41	-32.41
MW-5	-32.50	-32.41	-32.41	-28.41	-28.41	-32.5	-31.21	-30.31	-32.0	-28.8	-31.11	-32.41	-32.41	-32.41
MW-6	-32.50	-32.41	-32.41	-28.41	-28.41	-32.5	-31.21	-30.31	-32.0	-28.8	-31.11	-32.41	-32.41	-32.41
MW-7	-32.50	-32.41	-32.41	-28.41	-28.41	-32.5	-31.21	-30.31	-32.0	-28.8	-31.11	-32.41	-32.41	-32.41
MW-8	-32.50	-32.41	-32.41	-28.41	-28.41	-32.5	-31.21	-30.31	-32.0	-28.8	-31.11	-32.41	-32.41	-32.41
MW-9	-32.50	-32.41	-32.41	-28.41	-28.41	-32.5	-31.21	-30.31	-32.0	-28.8	-31.11	-32.41	-32.41	-32.41
MW-10	-32.50	-32.41	-32.41	-28.41	-28.41	-32.5	-31.21	-30.31	-32.0	-28.8	-31.11	-32.41	-32.41	-32.41
MW-11	-32.50	-32.41	-32.41	-28.41	-28.41	-32.5	-31.21	-30.31	-32.0	-28.8	-31.11	-32.41	-32.41	-32.41
MW-12	-32.50	-32.41	-32.41	-28.41	-28.41	-32.5	-31.21	-30.31	-32.0	-28.8	-31.11	-32.41	-32.41	-32.41
MW-13	-32.50	-32.41	-32.41	-28.41	-28.41	-32.5	-31.21	-30.31	-32.0	-28.8	-31.11	-32.41	-32.41	-32.41
MW-14	-32.50	-32.41	-32.41	-28.41	-28.41	-32.5	-31.21	-30.31	-32.0	-28.8	-31.11	-32.41	-32.41	-32.41
MW-15	-32.50	-32.41	-32.41	-28.41	-28.41	-32.5	-31.21	-30.31	-32.0	-28.8	-31.11	-32.41	-32.41	-32.41
MW-16	-32.50	-32.41	-32.41	-28.41	-28.41	-32.5	-31.21	-30.31	-32.0	-28.8	-31.11	-32.41	-32.41	-32.41
MW-17	-32.50	-32.41	-32.41	-28.41	-28.41	-32.5	-31.21	-30.31	-32.0	-28.8	-31.11	-32.41	-32.41	-32.41
MW-18	-32.50	-32.41	-32.41	-28.41	-28.41	-32.5	-31.21	-30.31	-32.0	-28.8	-31.11	-32.41	-32.41	-32.41
MW-19	-32.50	-32.41	-32.41	-28.41	-28.41	-32.5	-31.21	-30.31	-32.0	-28.8	-31.11	-32.41	-32.41	-32.41
MW-20	-32.50	-32.41	-32.41	-28.41	-28.41	-32.5	-31.21	-30.31	-32.0	-28.8	-31.11	-32.41	-32.41	-32.41
MW-21	-32.50	-32.41	-32.41	-28.41	-28.41	-32.5	-31.21	-30.31	-32.0	-28.8	-31.11	-32.41	-32.41	-32.41
MW-22	-32.50	-32.41	-32.41	-28.41	-28.41	-32.5	-31.21	-30.31	-32.0	-28.8	-31.11	-32.41	-32.41	-32.41
MW-23	-32.50	-32.41	-32.41	-28.41	-28.41	-32.5	-31.21	-30.31	-32.0	-28.8	-31.11	-32.41	-32.41	-32.41
MW-24	-32.50	-32.41	-32.41	-28.41	-28.41	-32.5	-31.21	-30.31	-32.0	-28.8	-31.11	-32.41	-32.41	-32.41
MW-25	-32.50	-32.41	-32.41	-28.41	-28.41	-32.5	-31.21	-30.31	-32.0	-28.8	-31.11	-32.41	-32.41	-32.41
MW-26	-32.50	-32.41	-32.41	-28.41	-28.41	-32.5	-31.21	-30.31	-32.0	-28.8	-31.11	-32.41	-32.41	-32.41
MW-27	-32.50	-32.41	-32.41	-28.41	-28.41	-32.5	-31.21	-30.31	-32.0	-28.8	-31.11	-32.41	-32.41	-32.41
MW-28	-32.50	-32.41	-32.41	-28.41	-28.41	-32.5	-31.21	-30.31	-32.0	-28.8	-31.11	-32.41	-32.41	-32.41
MW-29	-32.50	-32.41	-32.41	-28.41	-28.41	-32.5	-31.21	-30.31	-32.0	-28.8	-31.11	-32.41	-32.41	-32.41
MW-30	-32.50	-32.41	-32.41	-28.41	-28.41	-32.5	-31.21	-30.31	-32.0	-28.8	-31.11	-32.41	-32.41	-32.41
MW-31	-32.50	-32.41	-32.41	-28.41	-28.41	-32.5	-31.21	-30.31	-32.0	-28.8	-31.11	-32.41	-32.41	-32.41
MW-32	-32.50	-32.41	-32.41	-28.41	-28.41	-32.5	-31.21	-30.31	-32.0	-28.8	-31.11	-32.41	-32.41	-32.41
Flagstaff Supply Wells														
WMC-5	-24.45	-28.81	-32.35	-50.45	-12.45	-12.8	-32.15	-32.35	-32.1	-12.45	-12.65	-24.45	-12.45	-32.15
WMC-9	-34.15	-28.81	-28.81	-28.50	-34.12	-28.1	-28.50	-28.81	-28.1	-34.11	-36.45	-30.53	-30.53	-34.45
WMC-1	-14.15	-12.81	-12.81	-32.50	-12.0	-28.1	-32.50	-28.50	-28.9	-28.52	-12.50	-24.45	-34.45	-32.45
WMC-E3	-35.14	-32.11	-32.35	-18.00	-14.45	-9.9	-12.35	-20.00	-9.9	-20.36	-10.64	-14.44	-20.64	-23.84
WMC-K1	-32.84	-14.81	-14.81	-32.45	-32.45	-12.4	-12.35	-14.09	-36.9	-34.44	-36.66	-30.00	-30.00	-32.84
WMC-WMSR	-33.28	-33.28	-14.32	-34.32	--	-30.8	-34.30	-34.3	-30.1	-32.25	-34.12	--	-34.12	-34.12

Note - All water level measurements in ft. msl
-- Not measured

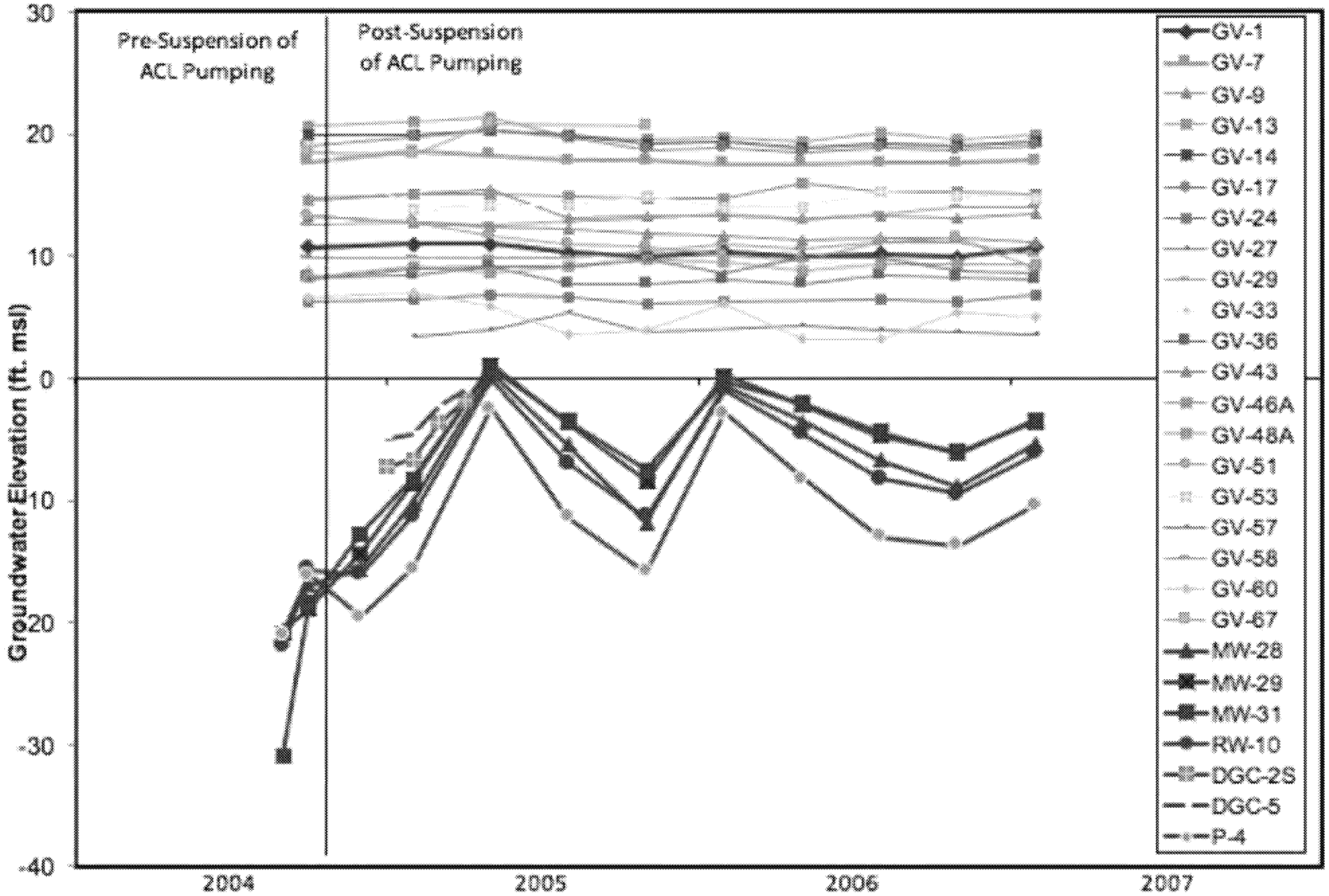
Attachment 5A (cont'd)

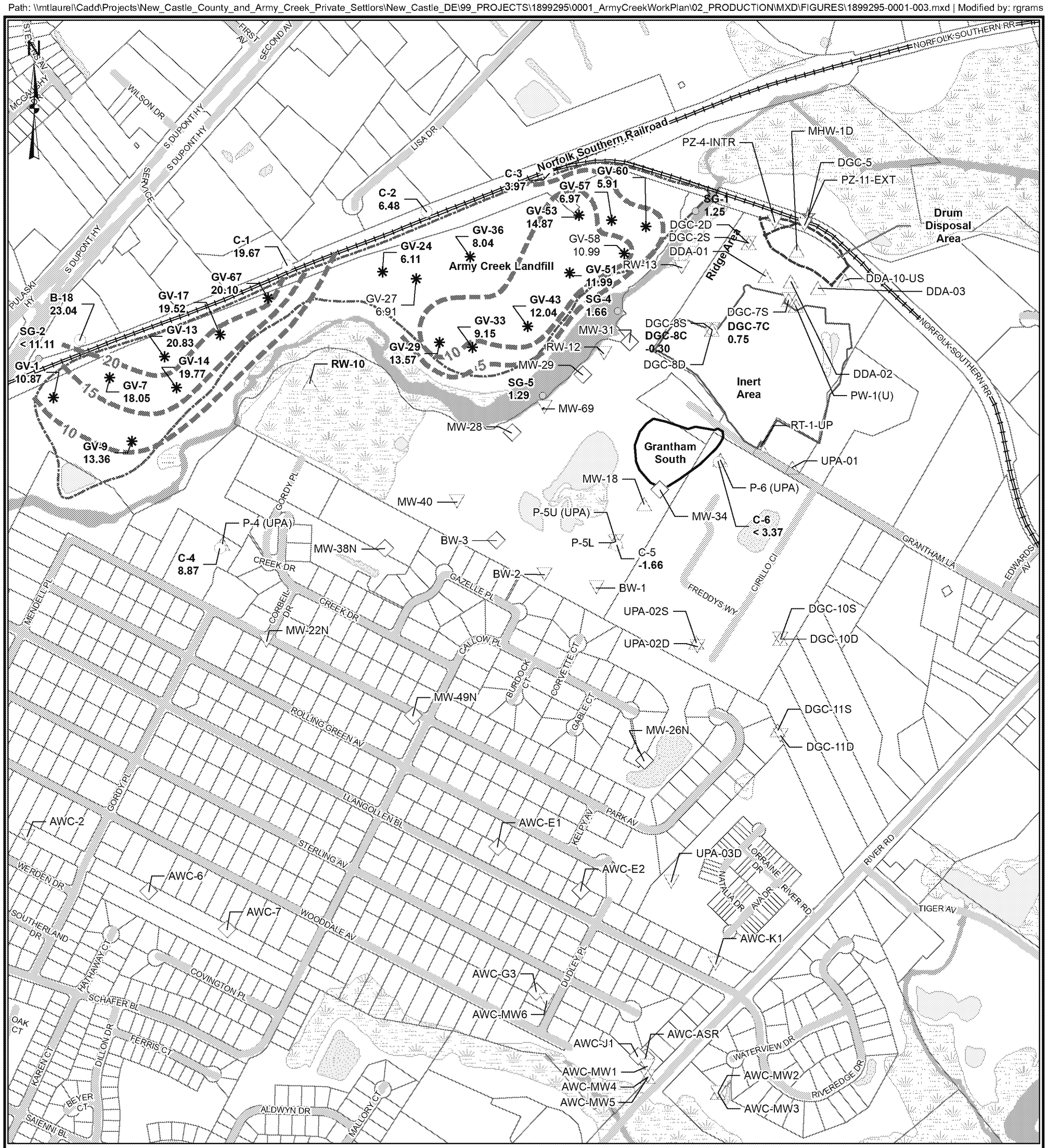
Summary of Water-Level Elevations for Bump-Pre-Test Snapshot Water-Level Snapshot
Activity at the Vista Creek Pre Delaware Bass & Closed Landfills

	Bump-Snapshot Water Level	Pre-Test Snapshot Water Level											
	09/13/00	09/13/00	09/20/00	09/26/00	09/27/00	10/11/00	10/24/00	10/30/00	11/07/00	11/21/00	12/06/00	12/18/00	01/30/01
Gas Vents													
1-AG	88.05	94.04	--	--	90.05	90.50	90.05	90.10	89.81	89.48	89.89	89.19	90.91
2-AG	91.11	95.05	--	--	92.55	91.82	91.18	91.21	91.29	91.09	91.08	91.18	92.02
3-AG	91.91	92.12	--	--	92.46	92.40	92.50	92.31	92.11	92.38	92.01	92.40	93.38
4-AG	90.50	95.05	--	--	94.45	91.68	92.68	92.63	92.30	92.02	92.09	90.00	90.93
5-AG	92.81	92.91	--	--	90.93	92.84	92.44	92.41	92.87	92.13	92.01	92.44	92.11
6-AG	92.81	92.95	--	--	90.47	92.68	92.12	92.84	92.47	92.90	92.89	92.81	92.25
7-AG	90.9	92.12	--	--	92.31	92.34	92.03	92.9	<92.25	92.31	92.34	92.12	92.44
8-AG	<93.34	92.9	--	--	92.7	92.44	92.8	<92.5	92.51	92.85	92.10	92.00	92.84
9-AG	89.21	93.21	--	--	93.01	<93.09	93.48	93.91	93.84	93.31	93.09	93.80	93.91
10-AG	8.8	<92.9	--	--	92.8	92.94	92.8	92.8	92.83	92.52	92.24	92.14	92.42
11-AG	92.8	92.9	--	--	92.50	92.91	93.13	93.14	93.13	92.87	92.31	92.00	92.04
12-AG	93.31	93.90	--	--	93.45	93.33	93.83	93.93	94.31	94.24	94.49	94.50	93.04
13-AG	92.91	93.01	--	--	93.01	92.84	93.13	92.91	92.90	92.38	92.48	92.09	92.82
14-AG	92.8	91.8	--	--	92.93	92.8	92.83	92.93	92.83	92.30	92.31	92.52	92.35
15-AG	93.3	92.5	--	--	94.94	92.95	92.94	90.01	92.92	94.08	94.45	92.9	94.83
16-AG	91.81	93.91	--	--	94.91	94.44	92.98	93.93	94.98	92.41	94.88	94.98	94.91
17-AG	92.8	92.8	--	--	92.8	92.53	92.10	92.9	92.10	92.8	92.94	92.9	92.81
18-AG	92.8	98.8	--	--	92.8	<92.81	92.92	90.91	92.93	94.10	94.14	94.40	92.93
19-AG	92.1	92.9	--	--	94.9	94.9	92.8	92.9	92.50	93.51	92.43	92.0	92.84
20-AG	91.81	93.81	--	--	92.11	<92.63	92.63	<92.41	< 92.52	< 92.81	< 92.81	< 92.81	92.40
Surface Water													
1-SS	10.5	Gauge Reading	--	--	--	--	--	--	--	--	--	--	--
2A-SS	Pelletsel Ion	Pelletsel Ion	91.1	91.1	91.1	92.0	92.0	93.5	92.0	92.0	91.9	--	91.5
3-SS	92.11	q_{ip}[a]	--	--	--	--	--	--	--	--	--	--	--
3A-SS	Pelletsel Ion	Pelletsel Ion	10.11	89.01	q_{ip}	q_{ip}	92.11 >	92.11 >	<11.92	<11.11	11.39	15.04	<11.11
5-SS	90.91	q_{ip}[a]	--	11.01	q_{ip}	90.91	90.91 >	<10.91	<10.91	10.10	--	15.54	--
7-SS	Pelletsel Ion	Pelletsel Ion	11.1	12.1	92.1	92.1	92.1	--	91.9	91.9	91.8	92.0	91.9
9-SS	Pelletsel Ion	Pelletsel Ion	11.1	92.1	92.1	92.1	92.1	--	91.4	91.8	91.9	92.52	91.9

[a] - Measured on January 18, 2002
Note - If at structure/seal level, refer to Pelletsel Ion
-- - Pelletsel Ion

Attachment 5B: Groundwater Elevations in the Army Creek Landfill Gas Vents and Vicinity





LEGEND

- WELL SCREENED IN UPCU TRANSITION ZONE
- WELL SCREENED IN UPA UPPER SAND
- WELL SCREENED IN UPA LOWER SAND
- WELL SCREENED ACROSS UPA UPPER SAND AND LOWER SAND
- WELL SCREENED IN COLUMBIA AQUIFER
- GAS VENT
- STAFF GAUGE
- INFERRED GROUNDWATER CONTOUR

REFERENCE

1. Base data from New Castle County Delaware, Department of Land Use, "eParcel View Map" web site GIS data download. Data acquired 01/18/2012.
2. Staff Gauges digitized from hard copy of Figure 1, Titled "Well Location Map," prepared by Ruth Associates, Inc. dated June 6, 2010.
3. Gas Vents digitized from hard copy of Figure 2, Titled "Groundwater Sample Locations Army Creek Landfill Site January 2005," prepared by Tetra Tech Inc.

ATTACHMENT 5C

REVIEW		
CHECK		
GIS	AM	12/7/2018
DESIGN	BAR	12/7/2018
REV. 0	SCALE: AS SHOWN	
FILE No.	1899295-0001-003	
PROJECT No.	013-6052.007	

TITLE

COLUMBIA AQUIFER GROUNDWATER CONTOUR MAP APRIL 2007

PROJECT

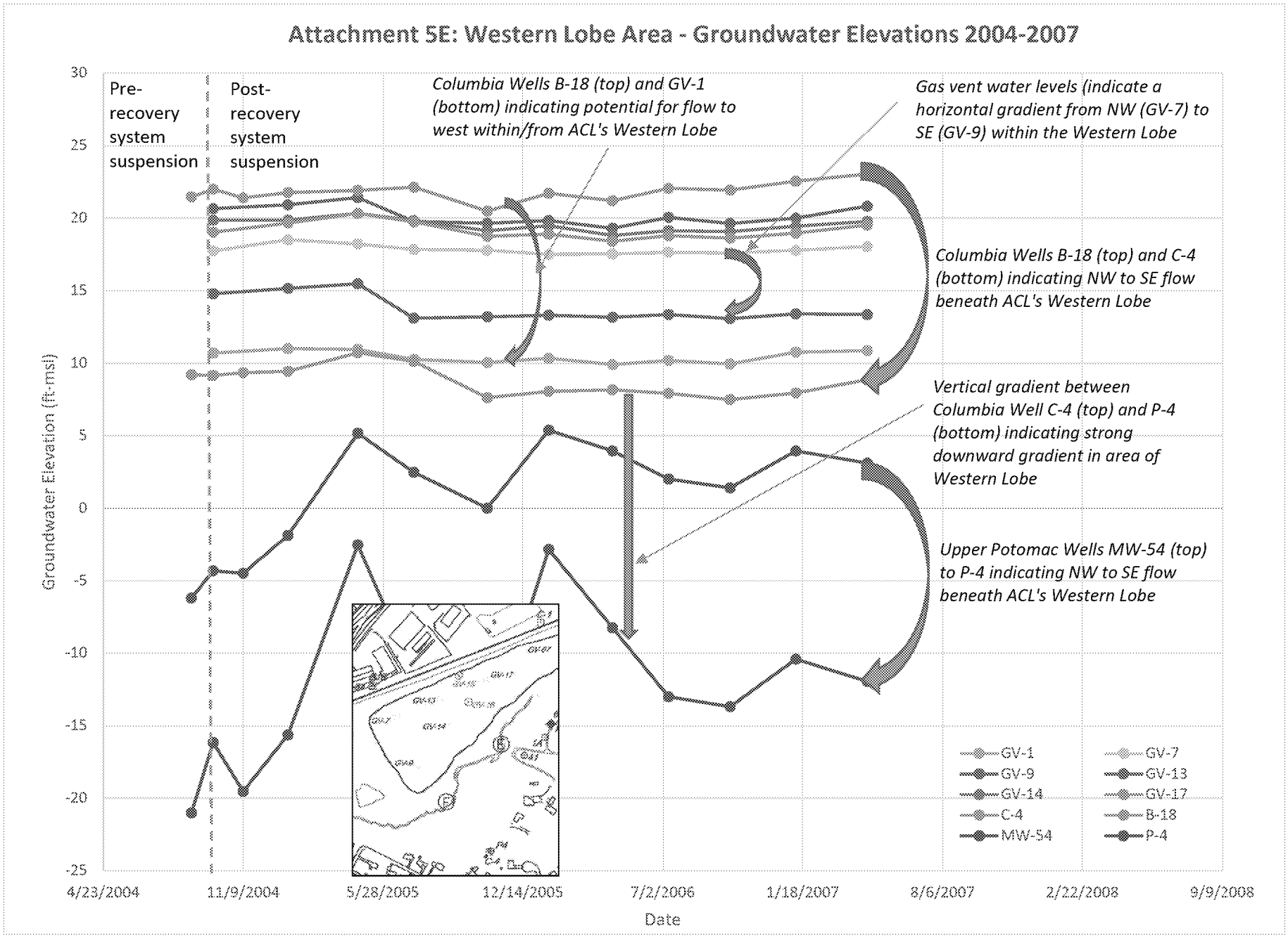
Army Creek Landfill Superfund Site New Castle, Delaware

GOLDER

Attachment 5D
Vertical Gradient Assessment
Army Creek Landfill Superfund Site
New Castle County, Delaware

Measurement Locations	Aquifer	Gradient	Measurement	Unit	Measurement Dates						Minimum	Average	Maximum	General Gradient Direction
					4/20-22/2005	10/24/2005	4/21-24/2006	10/6/2006	1/8/2007	4/20-24/2007				
SG-2B	Surface Water/Columbia	--	GWE	ft-msl	dry	<11.84	<11.35	11.34	12.04	<11.11	--	--	--	--
GV-1 (outside capped landfill)	Columbia	--	GWE	ft-msl	10.95	10.04	9.91	9.95	10.76	10.87	--	--	--	--
		Surface water - groundwater	HD	ft	-	-	-	-1.39	-1.28	-	-1.39	-1.34	-1.28	Likely losing stream section
C-2	Columbia	--	GWE	ft-msl	7.98	12.80	5.01	4.31	4.75	6.48	--	--	--	--
MW-56	UPA - Upper Sand	--	GWE	ft-msl	3.36	-3.56	1.00	-2.29	0.56	0.24	--	--	--	--
		Columbia to UPA	HD	ft	-4.62	-16.36	-4.01	-6.60	-4.19	-6.24	-16.36	-7.00	-4.01	Downward-Columbia to UPA
C-3	Columbia	--	GWE	ft-msl	-	2.46	2.44	2.83	2.31	2.31	--	--	--	--
MW-57	UPA - Upper Sand	--	GWE	ft-msl	3.70	-1.22	2.22	-0.39	1.87	1.81	--	--	--	--
		Columbia to UPA	HD	ft	-	-3.68	-0.22	-3.22	-0.44	-0.50	-3.68	-1.61	-0.22	Downward-Columbia to UPA
C-4	Columbia	--	GWE	ft-msl	10.72	7.62	8.17	7.49	7.95	8.87	--	--	--	--
P-4	UPA - Upper Sand	--	GWE	ft-msl	-2.53	-15.90	-8.25	-13.69	-10.41	-11.95	--	--	--	--
		Columbia to UPA	HD	ft	-13.25	-23.52	-16.42	-21.18	-18.36	-20.82	-23.52	-18.93	-13.25	Downward-Columbia to UPA
C-5	Columbia	--	GWE	ft-msl	2.33	-7.23	-0.79	-6.62	-2.87	-1.66	--	--	--	--
P5U	UPA - Upper Sand	--	GWE	ft-msl	-1.31	-15.53	-6.88	-11.86	-9.12	-10.13	--	--	--	--
		Columbia to UPA	HD	ft	-3.64	-8.30	-6.09	-5.24	-6.25	-8.47	-8.47	-6.33	-3.64	Downward-Columbia to UPA
C-6	Columbia	--	GWE	ft-msl	4.87	5.39	3.73	<3.37	<3.37	<3.37	--	--	--	--
P-6	UPA - Upper Sand	--	GWE	ft-msl	-0.53	-11.02	-4.37	-8.74	-6.01	-6.25	--	--	--	--
		Columbia to UPA	HD	ft	-5.40	-16.41	-8.10	-	-	-	-16.41	-9.97	-5.40	Downward-Columbia to UPA
B-18	Columbia	--	GWE	ft-msl	21.91	20.49	21.21	21.94	22.56	23.04	--	--	--	--
MW-54	UPA - Upper Sand	--	GWE	ft-msl	5.16	0.01	3.95	1.41	3.96	3.11	--	--	--	--
		Columbia to UPA	HD	ft	-16.75	-20.48	-17.26	-20.53	-18.60	-19.93	-20.53	-18.93	-16.75	Downward Columbia to UPA
DGC-7C	Columbia	--	GWE	ft-msl	-	-2.69	1.75	-	-0.91	-	--	--	--	--
DGC-7S	UPA - Upper Sand	--	GWE	ft-msl	0.67	-7.36	-2.31	-	-3.94	-2.88	--	--	--	--
		Columbia to UPA	HD	ft	-	-4.68	-4.07	-	-3.04	-	-4.68	-3.93	-3.04	Downward Columbia to UPA
DGC-8C	Columbia	--	GWE	ft-msl	-	-5.21	1.57	-	6.71	-	--	--	--	--
DGC-8S	UPA - Upper Sand	--	GWE	ft-msl	-	-7.56	-0.53	-	3.29	-	--	--	--	--
		Columbia to UPA	HD	ft	-	-2.35	-2.10	-	-3.42	-	-3.42	-2.62	-2.10	Downward Columbia to UPA

Abbreviations:
1) UPA = Upper Potomac Aquifer
2) GWE = groundwater elevation
3) HD = head difference
4) ft-msl = elevation in feet relative to mean sea level
5) NM = not measured
6) - = No data
7) During the period covered by these measurement dates, extraction from wells PW-1, AWC-2, AWC-7, AWC-G3 and AWC-K1 was ongoing.


Attachment 5E: Western Lobe Area - Groundwater Elevations 2004-2007
Pre-recovery system suspension
Post-recovery system suspension
Columbia Wells B-18 (top) and GV-1 (bottom) indicating potential for flow to west within/from ACL's Western Lobe
Gas vent water levels (indicate a horizontal gradient from NW (GV-7) to SE (GV-9) within the Western Lobe
Columbia Wells B-18 (top) and C-4 (bottom) indicating NW to SE flow beneath ACL's Western Lobe
Vertical gradient between Columbia Well C-4 (top) and P-4 (bottom) indicating strong downward gradient in area of Western Lobe
Upper Potomac Wells MW-54 (top) to P-4 indicating NW to SE flow beneath ACL's Western Lobe
Groundwater Elevation (ft-msl)
30
25
20
15
10
5
0
-5
-10
-15
-20
-25
4/23/2004
11/9/2004
5/28/2005
12/14/2005
7/2/2006
1/18/2007
8/6/2007
2/22/2008
9/9/2008
Date
GV-1
GV-7
GV-9
GV-13
GV-14
GV-17
C-4
B-18
MW-54
P-4

ATTACHMENT 6

SUMMARY OF SURFACE-WATER QUALITY DATA FOR ARMY CREEK AND ARMY POND

Attachment 6

Summary of Surface-Water Quality Data for Army Creek and Army Pond

Parameter	BTAG Screening Level µg/l	SWA 10/04	1/05	4/05	7/05	10/05	1/06	4/06	7/06	10/06	1/07	4/07	10/09	10/10	10/11	10/12	10/17
Non-Halogenated VOCs (µg/l)																	
Benzene	370	0.44 J	5 U	5 U	5 UJ	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
Toluene	2	0.25	5 U	5 U	5 UJ	5 UJ	10 U	0.30 J	1 U	1 U	1 U	1 U	--	--	--	--	--
Ethylbenzene	90	0.5 U	5 U	5 U	5 UJ	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
Xylene (total)	13	0.5 U	5 U	5 U	5 UJ	5 U	10 U	3 U	3 U	3 U	3 U	3 U	--	--	--	--	--
2-Butanone	14000	5 U	10 R	10 R	10 R	10 UJ	10 U	5 U	5 U	5 U	5 U	5 U	--	--	--	--	--
Acetone	1500	5.8 U	20 R	20 R	20 R	20 R	1.5 J	5 UJ	8.7 U	5 U	5 UJ	5 U	--	--	--	--	--
Carbon Disulfide	0.92	0.21 J	5 U	5 U	5 UJ	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
Cyclohexane		0.5 U	--	--	--	--	10 U	1 U	1 U	1 U	1 U	1 UJ	--	--	--	--	--
Isopropylbenzene	2.6	0.5 U	--	--	--	--	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
Methy-tert-butyl ether	11070	0.5	--	--	--	--	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
Methylcyclohexane		0.5 U	--	--	--	--	10 U	1 U	1 U	1 U	1 U	1 UJ	--	--	--	--	--
4-Methy-2-pentanone	170	5 U	10 U	10 U	10 UJ	10 UJ	10 U	5 U	5 U	5 U	5 U	5 U	--	--	--	--	--
Halogenated VOCs (µg/l)																	
Bromoform	320	0.5 U	5 U	5 U	5 UJ	5 UJ	10 UJ	1 U	1 U	1 U	1 U	1 UJ	--	--	--	--	--
Bromodichloromethane		0.5 U	5 U	5 U	5 UJ	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
Carbon Tetrachloride	13.3	0.5 U	5 U	5 U	5 UJ	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
Chlorobenzene	1.3	1.4	5 U	5 U	5 UJ	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
Chloroform	1.8	0.5 U	5 U	5 U	5 UJ	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
Dibromochloromethane		0.5 U	5 U	5 U	5 UJ	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
1,2-Dichloroethane	100	0.5 U	5 U	5 U	5 UJ	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
1,1-Dichloroethane	47	0.5 U	5 U	5 U	5 UJ	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
cis-1,2-Dichloroethene		0.5 U	5 U	5 U	5 UJ	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
trans-1,2-Dichloroethene	970	0.5 U	5 U	5 U	5 UJ	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
1,1-Dichloroethene	25	0.11 J	5 U	5 U	5 UJ	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
1,2-Dichlorobenzene	0.7	0.5 U	--	--	--	--	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
1,3-Dichlorobenzene	150	0.5 U	--	--	--	--	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
1,4-Dichlorobenzene	26	0.2 J	--	--	--	--	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
Chloroethane		0.5 U	5 U	5 U	5 UJ	5 UJ	10 U	1 R	1 U	1 U	1 U	1 U	--	--	--	--	--
Tetrachloroethene	111	0.5 U	5 U	5 U	5 UJ	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
1,1,1-Trichloroethane	11	0.5 U	5 U	5 U	5 UJ	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
Trichloroethene	21	0.5 U	5 U	5 U	5 UJ	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
Vinyl Chloride	930	0.5 U	5 U	5 U	5 UJ	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
1,2,4-Trichlorobenzene	24	0.5 U	--	--	--	--	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
cis-1,3-Dichloropropene		0.5 U	5 U	5 U	5 UJ	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
Methylene Chloride	98.1	0.5 U	5 U	5 U	5 UJ	5 UJ	10 U	1 U	1 UJ	1 UJ	1 U	1 U	--	--	--	--	--
Trichlorofluoromethane		0.5 U	--	--	--	--	10 U	1 UJ	1 U	1 U	1 U	1 U	--	--	--	--	--
Semi-Volatiles (µg/l)																	
1,1'-Biphenyl	14	5 U	5 U	5 U	5 UJ	5 U	5 U	5 U	5 U	5 UL	5 U	5 UL	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
2,2'-oxybis (1-Chloropropane)		5 U	5 U	5 U	5 UJ	5 U	5 UL	5 U	5 U	5 UL	5 U	5 UL	5.0 U	5.0 U	5.0 U	5.0 U	--
2,4-Dimethylphenol		5 U	5 U	5 U	5 UJ	5 U	5 U	5 U	5 U	5 U	5 U	5 UL	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
2,4-Dinitrophenol		20 U	20 U	20 J	20 UJ	20 U	20 UL	20 U	20 UL	20 U	20 U	20 UL	10 U	10 U	10 U	10 UJ	10 U
2,6-Dinitrotoluene	81	5 U	5 U	5 U	5 UJ	5 U	5 U	5 U	5 U	5 U	5 U	5 UL	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
2-Methylnaphthalene	4.7	5 U	5 U	5 U	5 UJ	5 U	5 U	5 U	5 U	5 U	5 U	5 UL	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
2-Methylphenol	13	5 U	5 U	5 U	5 UJ	5 U	5 U	5 U	5 U	5 U	5 U	5 UL	5.0 U	5.0 U	5.0 U	5.0 U	10 U
4,6-Dinitro-2-methylphenol		20 U	20 U	20 U	20 UJ	20 U	20 UL	20 U	20 U	20 U	20 U	20 UL	10 U	10 U	10 U	10 U	10 U
4-Methylphenol	543	5 U	5 U	5 U	5 UJ	5 U	5 U	5 U	5 U	5 U	5 U	5 UL	5.0 U	5.0 U	5.0 U	5.0 U	10 U
Acetophenone		5 U	5 U	5 U	5 UJ	5 U	5 U	5 U	5 U	5 U	5 U	5 UL	5.0 U	5.0 U	5.0 U	5.0 U	10 U
Atrazine	1.8	5 UJ	5 U	5 U	5 UL	5 U	5 UL	5 UL	5 U	5 U	5 UL	5 UL	5.0 UJ	5.0 U	5.0 U	5.0 U	10 U
Benzaldehyde		5 UJ	5 U	5 UL	5 UL	5 U	5 U	5 UL	5 U	5 U	5 U	5 UL	5.0 UJ	5.0 UJ	5.0 U	5.0 UJ	10 U
Benzo (a) pyrene	0.015	5 U	5 U	5 UL	5 UL	5 U	5 U	5 U	5 U	5 UL	5 UL	5 UL	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Benzo (b) Fluoranthene		5 U	5 U	5 UL	5 UL	5 U	5 U	5 U	5 U	5 UL	5 UL	5 UL	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Benzo (g,h,i) Perylene		5 U	5 U	5 UL	5 UL	5 U	5 U	5 U	5 U	5 UL	5 UL	5 UL	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Benzo (k) Fluoranthene		5 U	5 U	5 UL	5 UL	5 U	5 U	5 U	5 U	5 UL	5 UL	5 UL	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Bis(2-chloroethyl)Ether		1.8 J	0.04 B	0.081	0.02 UJ	0.02 UL	5 U	5 U	5 U	5 UL	5 U	5 UL	5.0 U	5.0 U	5.0 U	5.0 U	10 U
Bis(2-ethylhexyl)phthalate	16	5 U	5 U	5 U	7.6 J	5 U	5 U	5 UL	5 U	5 UL	5 UL	5 UL	5.0 U	5.0 U	5.0 U	5.0 UJ	5.0 U
Caprolactam		5 UJ	5 U	5 U	5 UJ	5 U	5 UL	5 UL	5 U	5 UL	5 UL	5 UL	5.0 U	5.0 UJ	5.0 U	5.0 U	10 U
Di-n-butyl phthalate	19	5 U	5 U	5 U	5 UJ	5 U	5 U	5 U	5 U	5 UL	5 UL	5 UL	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Di-n-octyl phthalate	22	5 U	5 U	5 U	5 UL	5 U	5 U	5 U	5 U	5 UL	5 UL	5 UL	5.0 U	5.0 U	5.0 U	5.0 UJ	10 U
1,4-Dioxane		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2.0 U
Dibenzo (a,h) Anthracene		5 U	5 U	5 UL	5 UL	5 U	5 U	5 U	5 U	5 UL	5 UL	5 UL	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Diethylphthalate	210	5 U	5 U	5 U	5 UJ	5 U	5 UL	5 U	5 U	5 UL	5 UL	5 UL	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Hexachlorocyclopentadiene		5 U	5 U	5 U	5 UJ	5 U	5 UL	5 U	5 U	5 U	5 U	5 UL	5.0 U	5.0 R	5.0 U	5.0 U	10 U
Indeno (1,2,3-cd) Pyrene		5 U	5 U	5 UL	5 UL	5 U	5 U	5 U	5 U	5 UL	5 UL	5 UL	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
N-Nitrosodiphenylamine	210	5 U	5 U	5 UJ	5 UJ	5 U	5 UL	5 U	5 U	5 U	5 U	5 UL	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Naphthalene	1.1	5 U	5 U	5 U	5 UJ	5 U	5 U	5 U	5 U	5 U	5 U	5 UL	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Pentachlorophenol	0.5	5 U	5 U	5 UJ	5 UJ	5 U	5 U	5 U	5 U	5 U	5 U	5 UL	5.0 U	5.0 U	5.0 U	5.0 U	10 U
Phenol	4	5 U	5 U	5 U	5 UJ	5 U	5 U	5 U	5 U	5 U	5 U	5 UL	5.0 U	5.0 U	5.0 U	5.0 U	10 U
Biological Oxygen Demand (mg/l)		--	--	3.9	3.7	2.1	4.2	4	7	6	--	--	--	--	--	--	--
Field Parameters																	
Temperature (Degrees Celcius)		16.12	--	14.04	31.7	12.9	8.2	16.0	32.1	16.8	6.5	19.1	14.4	18.0	18.6	13.4	21.6
Conductivity (µs/cm)		383	--	267	283	233	402	350	362	400	243	379	301	244	375	283	495
pH (standard units)	6.5 - 9	11.24	--	8.24	8.19	6.87	8.30	7.36	7.25	7.20	7.37	7.24	6.99	6.43	7.09	6.54	6.89
Dissolved Oxygen (mg/l)		6.18	--	8.68	8.20	6.04	9.85	5.66	9.23	7.30	8.53	10.79	6.58	5.72	3.13	4.45	3.44
ORP (mV)		-8.9	--	30.5	-4.0	50	77	133	45	39	88	155	60	147	59	105	194

U - Analyte was not detected above the reporting limit.
J - Estimated concentration.
B - Analyte Detected in Method Blank
-- Not analyzed

D - Sample diluted in the lab for analysis.
K - Analyte present. May be biased High.
L - Analyte present. May be biased low
R - Data Rejected

1/16/2018

Attachment 6 (continued)

Summary of Surface-Water Quality Data for Army Creek and Army Pond

Parameter	BTAG Screening Level µg/l	SWA 10/04	1/05	4/05	7/05	10/05	1/06	4/06	7/06	10/06	1/07	4/07	10/09	10/10	10/11	10/12	10/17
***Dissolved Inorganics* (µg/l)**																	
Aluminum	87	200 U	--	17 U	38.5 UJ	18.9 U	23.5 U	48.8 U	35.2 U	20.0 U	1100	11.1 U	200 U	200 U	200 U	200 U	200 U
Antimony	30	2.9	--	3.8 U	5.2 UJ	1.6 U	1.5 U	1.1 U	1.8 U	1.4 J	1.7	2.1 U	60.0 U	60.0 U	60.0 U	60.0 U	60.0 U
Arsenic	5	1.8 U	--	3 U	3.7 UJ	2 U	1.4 U	1.6 U	2.8 U	2.6 U	2.2 U	2.8 U	10.0 U	10.0 U	10.0 U	10.0 U	10 U
Barium	4	38.8	--	44.7	53.9 J	66.1	33.7	52.7	62.4	62.8	37.3	53.1	39.5 J	63.4 U	52.8 J	55.5 J	78.5 J
Beryllium	0.66	0.1 U	--	0.1 U	0.55 UJ	0.18 U	0.13 U	0.69 U	0.40 U	0.10 U	0.32 U	0.20 U	5.0 U	5.0 U	5.0 U	0.30 J	5.0 U
Cadmium	0.25	0.2 U	--	0.4 U	0.5 UJ	0.2 U	0.20 U	0.20 U	0.40 U	0.20 U	0.20 U	0.40 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Calcium	116000	41200	--	17900	16400 J	15400	10100	13800	18600	16400	9760	20700	14900	15800	17300	14200	23600
Chromium	85	0.5 U	--	2 U	1.1 UJ	0.6 U	0.40 U	0.60 U	0.50 U	0.73 U	1.9	0.30 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U
Cobalt	23	0.74	--	1.5 U	1.1 UJ	2.3	0.74	1.0	0.75	1.9 U	0.76 U	0.90 U	50.0 U	50.0 U	50.0 U	50.0 U	50.0 U
Copper	9	0.5 U	--	1.1	1.2 J	1.5	2.5	1.5 U	1.9 J	4.3 U	4.1 U	1.9 U	25.0 U	25.0 U	0.78 J	25 U	25.0 U
Iron (mg/l)	0.3	0.024	0.846 L	0.387	0.331 J	0.0634	0.159	0.316	0.298	0.0763 U	1.31	0.0445 U	0.140	0.231	0.100 UJ	0.210 J	0.114 U
Lead	2.5	0.9 U	--	1.3	1.6 UJ	1.1 U	1.0 U	1.0 U	1.9 U	1.6 U	1.3	2.3 U	10.0 U	10.0 U	10.0 U	10.0 U	10 U
Magnesium	82000	2010	--	5780	4190 J	4690	3910	4750	5640	5450	3520	7750	4720 J	5100	7230	5130	8280
Manganese (mg/l)	0.12	0.0057	0.271	0.273	0.030 J	0.0931	0.0871	0.167	0.111	0.123	0.0519	0.195	0.0862	0.102	0.0453	0.122	0.362
Mercury	0.026	0.2 U	--	0.1 U	0.1 UJ	0.1 U	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.20 U	0.20 U	0.20 U	0.20 U	0.026 J
Nickel	52	0.5 U	--	3.6 U	2.3 J	2.5	1.6	2.5	1.1	2.2 U	2.9 U	1.9	40.0 U	40.0 U	40.0 U	1.2 J	40.0 U
Potassium	53000	4850	--	3580 J	4260 J	4460	2110	4120	4670	5080	3110	3530 J	3780 J	2980 J	2860 J	3150 J	5780
Selenium	1	2.7	--	2.5 U	4.5 UJ	4.3 U	3.3 U	1.8 U	2.2 U	2.5 U	2.1 U	2.7 U	35.0 U	35.0 U	35.0 U	35.0 U	35.0 U
Silver	3.2	0.7 U	--	1.4 U	1.3 UJ	0.2 U	0.50 U	0.50 U	0.30 U	0.65 U	0.40 U	1.2 U	10.0 U	10.0 U	10.0 U	10.0 U	10 U
Sodium	680000	18800	--	39900	28400 J	13900	16700	22700	20000	16200	8280	43700	20600	24200	36400	26200	65200
Thallium	0.8	1.9 U	--	3.2 U	4 UJ	4.5 U	5.5	2.1 U	5.2 U	3.2 U	4.2 U	3.3 U	25.0 U	25.0 U	25.0 U	25.0 U	25.0 U
Vanadium	20	50 U	--	1 U	2 J	0.5 U	0.52	0.84	1.3	0.49 U	2.8 U	0.50 U	50.0 U	50.0 U	50.0 U	50.0 U	50.0 U
Zinc	120	2.4	--	13.3 U	2.7 UJ	7.9	11.3	2.3	3.6 U	4.5	14.9 U	1.7 U	60.0 U	5.2 J	3.9 J	60 U	60 U
***Pesticides/Herbicides* (µg/l)**																	
4,4'-DDD		0.018 U	0.02 U	0.02 U	0.02 UJ	0.02 U	0.020 U	--	--	--	--	--	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U
4,4'-DDE		0.0091 U	0.02 U	0.02 U	0.02 UJ	0.0084 J	0.020 U	--	--	--	--	--	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U
4,4'-DDT	0.0005	0.0091 U	0.02 U	0.02 U	0.02 UJ	0.02 U	0.020 U	--	--	--	--	--	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U
Aldrin	3	0.0091 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.010 U	--	--	--	--	--	0.029 J	0.050 U	0.067	0.050 U	0.050 U
alpha-BHC		0.0091 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.010 U	--	--	--	--	--	0.050 U	0.050 U	0.050 U	0.050 U	0.050 U
Alpha-Chlordane		0.0091 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.010 U	--	--	--	--	--	0.050 U	0.050 U	0.050 U	0.050 U	0.050 U
beta-BHC		0.0091 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.010 U	--	--	--	--	--	0.050 U	0.050 U	0.025 J	0.050 U	0.050 U
delta-BHC	141	0.0091 U	0.01 U	0.01 U	0.0019 JN	0.01 U	0.010 U	--	--	--	--	--	0.050 U	0.050 U	0.050 U	0.050 U	0.050 U
Dieldrin	0.056	0.018 U	0.02 U	0.02 U	0.02 U	0.0039 J	0.020 U	--	--	--	--	--	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U
Endosulfan I	0.051	0.0091 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.0038 J	--	--	--	--	--	0.050 U	0.050 U	0.050 U	0.050 U	0.050 U
Endosulfan II	0.051	0.018 U	0.02 U	0.02 U	0.02 UJ	0.02 U	0.020 U	--	--	--	--	--	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U
Endosulfan sulfate		0.018 U	0.02 U	0.02 U	0.02 UJ	0.0064 J	0.020 U	--	--	--	--	--	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U
Endrin	0.036	0.018 U	0.02 U	0.02 U	0.02 UJ	0.02 U	0.020 U	--	--	--	--	--	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U
Endrin Aldehyde		0.0029 J	0.02 U	0.02 U	0.02 UJ	0.02 U	0.020 U	--	--	--	--	--	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U
Endrin Ketone		0.018 U	0.02 U	0.02 U	0.02 UJ	0.02 U	0.020 U	--	--	--	--	--	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U
gamma-BHC (Lindane)	0.01	0.0068 J	0.01 U	0.01 U	0.01 UJ	0.01 U	0.010 U	--	--	--	--	--	0.050 U	0.050 U	0.050 U	0.050 U	0.050 UJ
gamma-Chlordane		0.0091 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.010 U	--	--	--	--	--	0.050 U	0.050 U	0.050 U	0.050 U	0.050 U
Heptachlor	0.0019	0.0091 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.010 U	--	--	--	--	--	0.050 U	0.050 U	0.050 U	0.050 U	0.050 U
Heptachlor Epoxide		0.011 J	0.01 U	0.014 JN	0.008 J	0.01 U	0.010 U	--	--	--	--	--	0.050 U	0.050 U	0.050 U	0.050 U	0.050 U
Methoxychlor	0.019	0.091 U	0.1 U	0.1 U	0.1 UJ	0.1 U	0.10 U	--	--	--	--	--	0.050 U	0.50 U	0.50 U	0.50 U	0.50 U
Toxaphene	0.0002	--	--	--	1 UJ	1 U	1.0 U	--	--	--	--	--	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U

U - Analyte was not detected above the reporting limit.
J - Estimated concentration.
B - Analyte Detected in Method Blank
-- Not analyzed
N - Analysis indicates the presence of an analyte for which there is presumptive evidence to make a "tentative identification"

D - Sample diluted in the lab for analysis.
K - Analyte present. May be biased High.
L - Analyte present. May be biased low
R - Data Rejected
P - Discrepency in GC analysis. Lower value reported.

1/16/2018

Attachment 6 (continued)

Summary of Surface-Water Quality Data for Army Creek and Army Pond

Parameter	BTAG Screening Level µg/l	SWB 10/04	1/05	4/05	7/05	10/05	1/06	4/06	7/06	10/06	1/07	4/07	10/09	10/10	10/11	10/12	10/17
Non-Halogenated VOCs (µg/l)																	
Benzene	370	0.51	2 J	5 U	5 U	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
Toluene	2	0.2	0.8 J	5 U	5 U	5 UJ	10 U	0.28 J	0.19 J	1 U	1 U	1 U	--	--	--	--	--
Ethylbenzene	90	0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
Xylene (total)	13	0.5 U	5 U	5 U	5 U	5 UJ	10 U	3 U	3 U	3 U	3 U	3 U	--	--	--	--	--
2-Butanone	14000	5 U	10 R	10 R	10 R	10 UJ	10 U	5 U	5 U	5 U	5 U	5 U	--	--	--	--	--
Acetone	1500	9.6	20 R	20 R	7 J	20 R	1.5 J	5 UJ	8.2 U	5 U	5 UJ	5 U	--	--	--	--	--
Carbon Disulfide	0.92	0.23 J	5 U	5 U	5 U	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
Cyclohexane		0.5 U	--	--	--	--	10 U	1 U	1 U	1 U	1 U	1 UJ	--	--	--	--	--
Isopropylbenzene	2.6	0.5 U	--	--	--	--	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
Methy-tert-butyl ether	11070	0.52	--	--	--	--	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
Methylcyclohexane		0.5 U	--	--	--	--	10 U	1 U	1 U	1 U	1 U	1 UJ	--	--	--	--	--
4-Methy-2-pentanone	170	5 U	10 U	10 U	10 UJ	10 UJ	10 U	5 U	5 U	5 U	5 U	5 U	--	--	--	--	--
Halogenated VOCs (µg/l)																	
Bromoform	320	0.5 U	5 U	5 U	5 U	5 UJ	10 UJ	1 U	1 U	1 U	1 U	1 UJ	--	--	--	--	--
Bromodichloromethane		0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
Carbon Tetrachloride	13.3	0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
Chlorobenzene	1.3	1.7	6	5 U	5 U	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
Chloroform	1.8	0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
Dibromochloromethane		0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
1,2-Dichloroethane	100	0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
1,1-Dichloroethane	47	0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
cis-1,2-Dichloroethene		0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
trans-1,2-Dichloroethene	970	0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
1,1-Dichloroethene	25	0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
1,2-Dichlorobenzene	0.7	0.5 U	--	--	--	--	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
1,3-Dichlorobenzene	150	0.5 U	--	--	--	--	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
1,4-Dichlorobenzene	26	0.22 J	--	--	--	--	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
Chloroethane		0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 R	1 U	1 U	1 U	1 U	--	--	--	--	--
Tetrachloroethene	111	0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
1,1,1-Trichloroethane	11	0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
Trichloroethene	21	0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
Vinyl Chloride	930	0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
1,2,4-Trichlorobenzene	24	0.5 U	--	--	--	--	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
cis-1,3-Dichloropropene		0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
Methylene Chloride	98.1	0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 U	1 UJ	1 UJ	1 U	1 U	--	--	--	--	--
Trichlorofluoromethane		0.5 U	--	--	--	--	10 U	1 UJ	1 U	1 U	1 U	1 U	--	--	--	--	--
Semi-Volatiles (µg/l)																	
1,1'-Biphenyl	14	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 UL	5.1 U	5.0 U	5.0 U	5.0 U	5.0 U
2,2'-oxybis (1-Chloropropane)		5 U	5 U	5 U	5 U	5 U	5 UL	5 U	5 U	5 U	5 U	5 UL	5.1 U	5.0 U	5.0 U	5.0 U	--
2,4-Dimethylphenol		5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 UL	5.1 U	5.0 U	5.0 U	5.0 U	5.0 U
2,4-Dinitrophenol		20 U	20 U	20 UJ	20 U	20 U	20 UL	20 U	20 UL	20 U	20 U	20 UL	10 U	10 U	10 U	10 U	10 U
2,6-Dinitrotoluene	81	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 UL	5.1 U	5.0 U	5.0 U	5.0 U	5.0 U
2-Methylnaphthalene	4.7	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 UL	5.1 U	5.0 U	5.0 U	5.0 U	5.0 U
2-Methylphenol	13	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 UL	5.1 U	5.0 U	5.0 U	5.0 U	10 U
4,6-Dinitro-2-methylphenol		20 U	20 U	20 U	20 U	20 U	20 UL	20 U	20 U	20 U	20 U	20 UL	10 U	10 U	10 U	10 U	10 U
4-Methylphenol	543	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 UL	5.1 U	5.0 U	5.0 U	5.0 U	10 U
Acetophenone		5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 UL	5.1 U	5.0 U	5.0 U	5.0 U	10 U
Atrazine	1.8	5 UJ	5 UL	5 U	5 U	5 U	5 UL	5 UL	5 U	5 U	5 UL	5 UL	5.1 UJ	5.0 U	5.0 U	5.0 U	10 U
Benzaldehyde		5 UJ	5 U	5 UL	5 UL	5 U	5 U	5 UL	5 U	5 U	5 U	5 UL	5.1 UJ	5.0 UJ	5.0 U	5.0 U	10 U
Benzo (a) pyrene	0.015	5 UL	5 UL	5 UL	5 UL	5 UL	5 U	5 U	5 U	5 UL	5 UL	5 UL	5.1 U	5.0 U	5.0 U	5.0 U	5.0 U
Benzo (b) Fluoranthene		5 UL	5 UL	5 UL	5 UL	5 UL	5 U	5 U	5 U	5 UL	5 UL	5 UL	5.1 U	5.0 U	5.0 U	5.0 U	5.0 U
Benzo (g,h,i) Perylene		5 UL	5 UL	5 UL	5 UL	5 UL	5 U	5 U	5 U	5 UL	5 UL	5 UL	5.1 U	5.0 U	5.0 U	5.0 U	5.0 U
Benzo (k) Fluoranthene		5 UL	5 UL	5 UL	5 UL	5 UL	5 U	5 U	5 U	5 UL	5 UL	5 UL	5.1 U	5.0 U	5.0 U	5.0 U	5.0 U
Bis(2-chloroethyl)Ether		2.2 J	0.095 B	0.065	0.02 U	0.019 U	5 U	5 U	5 U	5 U	5 U	5 UL	5.1 U	5.0 U	5.0 U	5.0 U	10 U
Bis(2-ethylhexyl)phthalate	16	5 U	54	5 U	5 U	5 U	5 U	5 UL	4.5 J	5 U	5 UL	5 UL	5.1 U	5.0 U	5.0 U	2.4 J	5.0 U
Caprolactam		5 UJ	5 U	5 U	5 UL	5 U	5 UL	5 UL	5 U	5 U	5 UL	5 UL	5.1 U	5.0 UJ	5.0 U	5.0 U	10 U
Di-n-butyl phthalate	19	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 UL	5 UL	5.1 U	5.0 U	5.0 U	5.0 U	5.0 U
Di-n-octyl phthalate	22	5 U	5 U	5 U	5 UL	5 U	5 U	5 U	5 U	5 U	5 UL	5 UL	5.1 U	5.0 U	5.0 U	5.0 U	10 U
1,4-Dioxane		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2.0 U
Dibenzo (a,h) Anthracene		5 UL	5 U	5 UL	5 UL	5 UL	5 U	5 U	5 U	5 UL	5 UL	5 UL	5.1 U	5.0 U	5.0 U	5.0 U	5.0 U
Diethylphthalate	210	5 U	5 U	5 U	5 U	5 U	5 UL	5 U	5 U	5 U	5 UL	5 UL	5.1 U	5.0 U	5.0 U	5.0 U	5.0 U
Hexachlorocyclopentadiene		5 U	5 U	5 U	5 R	5 U	5 UL	5 U	5 U	5 R	5 U	5 UL	5.1 U	5.0 R	5.0 U	5.0 U	10 U
Indeno (1,2,3-cd) Pyrene		5 UL	5 UL	5 UL	5 UL	5 U	5 U	5 U	5 U	5 UL	5 UL	5 UL	5.1 U	5.0 U	5.0 U	5.0 U	5.0 U
N-Nitrosodiphenylamine	210	5 U	5 U	5 UJ	5 U	5 U	5 UL	5 U	5 U	5 U	5 U	5 UL	5.1 U	5.0 U	5.0 U	5.0 U	5.0 U
Naphthalene	1.1	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 UL	5.1 U	5.0 U	5.0 U	5.0 U	5.0 U
Pentachlorophenol	0.5	5 U	5 U	5 UJ	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 UL	5.1 U	5.0 U	5.0 U	5.0 U	10 U
Phenol	4	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 UL	5.1 U	5.0 U	5.0 U	5.0 U	10 U
Biological Oxygen Demand (mg/l)		--	--	2.9	8.0	3.3	3.7	5	9	4	--	--	--	--	--	--	--
Field Parameters																	
Temperature (Degrees Celcius)		17.67	--	13.0	29.1	11.0	7.0	16.3	33.7	25.1	5.5	23.6	14.0	18.5	17.7	14.2	21.2
Conductivity (µs/cm)		318	--	263	453	238	342	306	514	297	136	307	330	240	390	318	393
pH (standard units)	6.5 - 9	7.99	--	8.53	6.78	6.93	7.17	7.20	8.71	7.45	6.58	8.69	7.16	6.72	7.00	6.62	7.12
Dissolved Oxygen (mg/l)		3.64	--	9.38	3.09	5.34	9.45	4.91	10.25	8.89	5.85	9.37	7.40	0.00	2.89	4.80	4.62
ORP (mV)		-161.4	--	62.9	11.2	130	118	69	70	79	94	49	-1	-51	1	-75	172

U - Analyte was not detected above the reporting limit.
J - Estimated concentration.
B - Analyte Detected in Method Blank
-- Not analyzed

D - Sample diluted in the lab for analysis.
K - Analyte present. May be biased High.
L - Analyte present. May be biased low
R - Data Rejected

1/16/2018

Attachment 6 (continued)

Summary of Surface-Water Quality Data for Army Creek and Army Pond

Parameter	BTAG Screening Level µg/l	SWB 10/04	1/05	4/05	7/05	10/05	1/06	4/06	7/06	10/06	1/07	4/07	10/09	10/10	10/11	10/12	10/17
***Dissolved Inorganics* (µg/l)**																	
Aluminum	87	200 U	--	26.8 U	44.6 U	14 U	16.6 U	46.3 U	66.1 U	20.0 U	30.3 U	29.6 U	200 U	200 U	200 U	200 U	200 U
Antimony	30	2 U	--	3.8 U	3.7 U	1.6 U	1.2 U	1.1 U	1.8 U	1.2 U	1.7 U	2.1 U	60.0 U	60.0 U	60.0 U	60.0 U	60.0 U
Arsenic	5	1.8 U	--	3 U	3.7 U	2 U	3.3	1.6 U	2.8 U	2.6 U	2.2 U	2.8 U	10.0 U	10.0 U	10.0 U	10.0 U	10 U
Barium	4	29.5	--	26.3 B	55.5	47.9	49	57.2	42.4	44.5	47.4	21.8	36.9 J	58.7 J	58.9 J	53.2 J	64.4 J
Beryllium	0.66	0.1 U	--	0.1 U	0.56 U	0.13 U	0.15 U	0.67 U	0.68 U	0.10 U	0.30 U	0.20 U	5.0 U	5.0 U	5.0 U	0.48 J	5.0 U
Cadmium	0.25	0.2 U	--	0.4 U	0.5 U	0.2 U	0.20 U	0.20 U	0.40 U	0.20 U	0.20 U	0.40 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Calcium	116000	31200	--	17900	16200	14800	15200	12400	17100	15300	12900	20400	16200	16300	24300	15400	21300
Chromium	85	0.5 U	--	1.2 U	1.1 U	0.6 U	0.40 U	0.60 U	0.50 U	0.45 U	0.60 U	0.37 U	10.0 U	10.0 U	10.0 U	10.0 U	10 U
Cobalt	23	50 U	--	1.2 U	1.3	0.5 U	1.4	0.73	0.70 U	0.54 U	0.40 U	0.90 U	50.0 U	50.0 U	50.0 U	50.0 U	50.0 U
Copper	9	0.5 U	--	1.2	0.8 U	1.1	0.65	0.67 U	1.5 U	3.5 U	2.9 U	2.2 U	25.0 U	25.0 U	1.1 J	25 U	25 U
Iron (mg/l)	0.3	0.0697	46.9	0.479 K	0.484	0.0466	0.104	0.249	0.405	0.0688 U	0.118 U	0.262	0.386	0.564	0.205	0.381	0.159 K
Lead	2.5	0.9 U	--	1.2 U	1.6 U	1.1	1.0 U	1.0 U	1.9 U	1.6 U	1.2 U	2.2 U	10.0 U	10.0 U	10.0 U	10.0 U	10 U
Magnesium	82000	2100	--	5980	4530	4970	6000	4410	5080	5570	4580	8050	5100	5290	8180	5650	6970
Manganese (mg/l)	0.12	0.0066	1.56	0.136	0.172	0.0209	0.104	0.189	0.0387	0.0546	0.0416	0.0294	0.100	0.193	0.0756	0.0886	0.128
Mercury	0.026	0.1 U	--	0.1 U	0.1 U	0.1 U	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
Nickel	52	0.5 U	--	3.1 U	2	2.5	1.5	1.9	1.3	2.1 U	1.6 U	1.7	40.0 U	40.0 U	40.0 U	1.3 J	40.0 U
Potassium	53000	5110	--	3290 J	4390	4140	2980	3780	4530	3290	4290	2500 J	3520 J	2770 J	3430 J	3370 J	10500
Selenium	1	2.6 U	--	1.7 U	4.5 U	4.3 U	3.3 UJ	1.8 U	2.2 U	2.5 U	3.1	2.7 U	35.0 U	35.0 U	35.0 U	35.0 U	35.0 U
Silver	3.2	0.7 U	--	1.4 U	1.3 U	0.2 U	0.50 U	0.50 U	0.30 U	0.50 U	0.40 U	1.2 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U
Sodium	680000	17500	--	40600	30900	15300	29500	20500	20200	16000	10800	47000	23700	25700	41100	29700	47900
Thallium	0.8	1.9 U	--	2.9 U	4 U	4.5 U	3.9 U	2.1 U	3.6 U	3.2 U	3.4 U	2.9 U	25.0 U	25.0 U	25.0 U	25.0 U	25.0 U
Vanadium	20	50 U	--	1.2 U	2.8	0.5 U	0.30 U	0.98 U	2.8	0.49 U	0.40 U	2.2 U	50.0 U	50.0 U	50.0 U	50.0 U	50.0 U
Zinc	120	0.7 U	--	11 U	3.9 U	3.9	4.3	0.80 U	4.6 U	2.6	10.3 U	1.9 U	60.0 U	2.5 J	4.0 J	60 U	7.8 J
***Pesticides/Herbicides* (µg/l)**																	
4,4'-DDD		0.018 U	0.02 U	0.02 U	0.02 U	0.02 U	0.020 U	--	--	--	--	--	0.10 U	0.10 U	0.11 U	0.10 U	0.10 U
4,4'-DDE		0.0091 U	0.02 U	0.02 U	0.013 J	0.012 J	0.020 U	--	--	--	--	--	0.10 U	0.10 U	0.11 U	0.10 U	0.10 U
4,4'-DDT	0.0005	0.0091 U	0.02 U	0.02 U	0.02 U	0.02 U	0.020 U	--	--	--	--	--	0.10 U	0.10 U	0.11 U	0.10 U	0.10 U
Aldrin	3	0.0091 U	0.01 U	0.01 U	0.01 U	0.01 U	0.010 U	--	--	--	--	--	0.050 U	0.050 U	0.026 J	0.050 U	0.050 U
alpha-BHC		0.0091 U	0.01 U	0.01 U	0.01 U	0.01 U	0.010 U	--	--	--	--	--	0.050 U	0.050 U	0.053 U	0.050 U	0.050 U
Alpha-Chlordane		0.0091 U	0.01 U	0.01 U	0.01 U	0.0013 J	0.010 U	--	--	--	--	--	0.050 U	0.050 U	0.053 U	0.050 U	0.050 U
beta-BHC		0.0091 U	0.01 U	0.01 U	0.01 U	0.01 U	0.010 U	--	--	--	--	--	0.050 U	0.050 U	0.053 U	0.050 U	0.050 U
delta-BHC	141	0.0091 U	0.01 U	0.01 U	0.01 U	0.01 U	0.010 U	--	--	--	--	--	0.050 U	0.050 U	0.053 U	0.050 U	0.050 U
Dieldrin	0.056	0.018 U	0.0027 J	0.02 U	0.02 U	0.02 U	0.020 U	--	--	--	--	--	0.10 U	0.10 U	0.11 U	0.10 U	0.10 U
Endosulfan I	0.051	0.0091 U	0.01 U	0.01 U	0.01 U	0.01 U	0.010 U	--	--	--	--	--	0.050 U	0.050 U	0.053 U	0.050 U	0.050 U
Endosulfan II	0.051	0.018 U	0.02 U	0.02 U	0.02 U	0.02 U	0.020 U	--	--	--	--	--	0.10 U	0.10 U	0.11 U	0.10 U	0.10 U
Endosulfan sulfate		0.0042 J	0.02 U	0.02 U	0.02 U	0.02 U	0.020 U	--	--	--	--	--	0.10 U	0.10 U	0.11 U	0.10 U	0.050 U
Endrin	0.036	0.018 U	0.02 U	0.02 U	0.02 U	0.02 U	0.020 U	--	--	--	--	--	0.10 U	0.10 U	0.11 U	0.10 U	0.10 U
Endrin Aldehyde		0.018 U	0.02 U	0.02 U	0.02 U	0.02 U	0.020 U	--	--	--	--	--	0.10 U	0.10 U	0.11 U	0.10 U	0.010 J
Endrin Ketone		0.018 U	0.02 U	0.02 U	0.02 U	0.02 U	0.020 U	--	--	--	--	--	0.10 U	0.10 U	0.11 U	0.10 U	0.10 U
gamma-BHC (Lindane)	0.01	0.0091 U	0.01 U	0.01 U	0.01 U	0.01 U	0.010 U	--	--	--	--	--	0.050 U	0.050 U	0.053 U	0.050 U	0.050 U
gamma-Chlordane		0.0091 U	0.01 U	0.01 U	0.01 U	0.01 U	0.010 U	--	--	--	--	--	0.050 U	0.050 U	0.053 U	0.050 U	0.10 U
Heptachlor	0.0019	0.0091 U	0.01 U	0.01 U	0.01 U	0.01 U	0.010 U	--	--	--	--	--	0.050 U	0.050 U	0.053 U	0.050 U	0.050 U
Heptachlor Epoxide		0.0091 U	0.01 U	0.01 UJ	0.01 U	0.01 U	0.010 U	--	--	--	--	--	0.050 U	0.050 U	0.053 U	0.050 U	0.050 U
Methoxychlor	0.019	0.091 U	0.1 U	0.1 U	0.1 U	0.0047 J	0.10 U	--	--	--	--	--	0.050 U	0.50 U	0.53 U	0.50 U	0.50 U
Toxaphene	0.0002	--	--	--	1 U	1 U	1.0 U	--	--	--	--	--	5.0 U	5.0 U	5.3 U	5.0 U	5.0 U

U - Analyte was not detected above the reporting limit.
J - Estimated concentration.
B - Analyte Detected in Method Blank
-- Not analyzed
N - Analysis indicates the presence of an analyte for which there is presumptive evidence to make a "tentative identification"

D - Sample diluted in the lab for analysis.
K - Analyte present. May be biased High.
L - Analyte present. May be biased low
R - Data Rejected
P - Discrepency in GC analysis. Lower value reported.

1/16/2018

Attachment 6 (continued)

Summary of Surface-Water Quality Data for Army Creek and Army Pond

Parameter	BTAG Screening Level µg/l	SWC 10/04	1/05	4/05	7/05	10/05	1/06	4/06	7/06	10/06	1/07	4/07	10/09	10/10	10/11	10/12	10/17
Non-Halogenated VOCs **(µg/l)**																	
Benzene	370	0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
Toluene	2	0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
Ethylbenzene	90	0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
Xylene (total)	13	0.5 U	5 U	5 U	5 U	5 UJ	10 U	3 U	3 U	3 U	3 U	3 U	--	--	--	--	--
2-Butanone	14000	5 U	10 U	10 R	10 R	10 UJ	10 U	5 U	5 U	5 U	5 U	5 U	--	--	--	--	--
Acetone	1500	5 U	10 J	20 R	20 R	20 R	10 U	5 UJ	10 U	5 U	5 UJ	6.8 U	--	--	--	--	--
Carbon Disulfide	0.92	0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
Cyclohexane		0.5 U	--	--	--	--	10 U	1 U	1 U	1 U	1 U	1 UJ	--	--	--	--	--
Isopropylbenzene	2.6	0.5 U	--	--	--	--	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
Methy-tert-butyl ether	11070	0.27 J	--	--	--	--	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
Methylcyclohexane		0.5 U	--	--	--	--	10 U	1 U	1 U	1 U	1 U	1 UJ	--	--	--	--	--
4-Methy-2-pentanone	170	5 U	10 U	10 U	10 U	10 UJ	10 U	5 U	5 U	5 U	5 U	5 U	--	--	--	--	--
Halogenated VOCs **(µg/l)**																	
Bromoform	320	0.5 U	5 U	5 U	5 U	5 UJ	10 UJ	1 U	1 U	1 U	1 U	1 UJ	--	--	--	--	--
Bromodichloromethane		0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
Carbon Tetrachloride	13.3	0.5 U	5 UJ	5 U	5 U	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
Chlorobenzene	1.3	0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
Chloroform	1.8	0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
Dibromochloromethane		0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
1,2-Dichloroethane	100	0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
1,1-Dichloroethane	47	0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
cis-1,2-Dichloroethene		0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
trans-1,2-Dichloroethene	970	0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
1,1-Dichloroethene	25	0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
1,2-Dichlorobenzene	0.7	0.5 U	--	--	--	--	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
1,3-Dichlorobenzene	150	0.5 U	--	--	--	--	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
1,4-Dichlorobenzene	26	0.11 J	--	--	--	--	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
Chloroethane		0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 R	1 U	1 U	1 U	1 U	--	--	--	--	--
Tetrachloroethene	111	0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
1,1,1-Trichloroethane	11	0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
Trichloroethene	21	0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
Vinyl Chloride	930	0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
1,2,4-Trichlorobenzene	24	0.5 U	--	--	--	--	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
cis-1,3-Dichloropropene		0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
Methylene Chloride	98.1	0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 U	1 UJ	1 UJ	1 U	1 U	--	--	--	--	--
Trichlorofluoromethane		0.5 U	--	--	--	--	10 U	1 UJ	1 U	1 U	1 U	1 U	--	--	--	--	--
Semi-Volatiles **(µg/l)**																	
1,1'-Biphenyl	14	5 U	5 U	5.1 U	5 U	5 U	5 U	5 U	5 U	5 UL	5 U	5 UL	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
2,2'-oxybis (1-Chloropropane)		5 UJ	5 U	5.1 U	5 U	5 U	5 UL	5 U	5 U	5 UL	5 U	5 UL	5.0 U	5.0 U	5.0 U	5.0 U	--
2,4-Dimethylphenol		5 U	5 U	5.1 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 UL	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
2,4-Dinitrophenol		20 U	20 U	21 UJ	20 U	20 U	20 UL	20 U	20 UL	20 UL	20 U	20 UL	10 U	10 U	10 U	10 U	10 U
2,6-Dinitrotoluene	81	5 UJ	5 U	5.1 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 UL	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
2-Methylnaphthalene	4.7	5 U	5 U	5.1 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 UL	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
2-Methylphenol	13	5 U	5 U	5.1 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 UL	5.0 U	5.0 U	5.0 U	5.0 U	10 U
4,6-Dinitro-2-methylphenol		20 U	20 U	21 U	20 U	20 U	20 UL	20 U	20 U	20 U	20 U	20 UL	10 U	10 U	10 U	10 U	10 U
4-Methylphenol	543	5 U	5 U	5.1 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 UL	5.0 U	5.0 U	5.0 U	5.0 U	10 U
Acetophenone		5 U	5 U	5.1 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 UL	5.0 U	5.0 U	5.0 U	5.0 U	10 U
Atrazine	1.8	5 U	5 U	5.1 U	5 U	5 U	5 UL	5 UL	5 U	5 UL	5 U	5 UL	5.0 UJ	5.0 U	5.0 U	5.0 U	10 U
Benzaldehyde		5 UJ	5 U	5.1 UL	5 UL	5 U	5 U	5 UL	5 U	5 U	5 U	5 UL	5.0 UJ	5.0 UJ	5.0 U	5.0 U	10 U
Benzo (a) pyrene	0.015	5 U	5 UL	5.1 UL	5 UL	5 U	5 U	5 UL	5 U	5 UL	5 U	5 UL	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Benzo (b) Fluoranthene		5 U	5 UL	5.1 UL	5 UL	5 U	5 U	5 UL	5 U	5 UL	5 U	5 UL	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Benzo (g,h,i) Perylene		5 U	5 UL	5.1 UL	5 UL	5 U	5 U	5 UL	5 U	5 UL	5 U	5 UL	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Benzo (k) Fluoranthene		5 U	5 UL	5.1 UL	5 UL	5 U	5 U	5 UL	5 U	5 UL	5 U	5 UL	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Bis(2-chloroethyl)Ether		0.93	0.043 B	0.073	0.019 U	0.02 UL	5 U	5 U	5 U	5 UL	5 U	5 UL	5.0 U	5.0 U	5.0 U	5.0 U	10 U
Bis(2-ethylhexyl)phthalate	16	5 U	5 U	5.1 U	5 U	5 U	5 U	5 UL	7.2 J	5 UL	5 U	4.1 L	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Caprolactam		5 UJ	5 U	5.1 U	5 U	5 U	5 UL	5 UL	5 U	5 UL	5 U	5 UL	5.0 U	5.0 UJ	5.0 U	5.0 U	10 U
Di-n-butyl phthalate	19	5 U	5 U	5.1 U	5 U	5 U	5 U	5 U	5 U	5 UL	5 U	5 UL	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Di-n-octyl phthalate	22	5 U	5 U	5.1 U	5 UL	5 U	5 U	5 U	5 U	5 UL	5 U	5 UL	5.0 U	5.0 U	5.0 U	5.0 U	10 U
1,4-Dioxane		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.0 J
Dibenzo (a,h) Anthracene		5 UJ	5 UL	5.1 UL	5 UL	5 U	5 U	5 UL	5 U	5 UL	5 U	5 UL	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Diethylphthalate	210	5 U	5 U	5.1 U	5 U	5 U	5 UL	5 U	5 U	5 UL	5 U	5 UL	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Hexachlorocyclopentadiene		5 U	5 U	5.1 U	5 U	5 U	5 UL	5 U	5 U	5 U	5 U	5 UL	5.0 U	5.0 R	5.0 U	5.0 U	10 U
Indeno (1,2,3-cd) Pyrene		5 UJ	5 UL	5.1 UL	5 UL	5 U	5 U	5 UL	5 U	5 UL	5 U	5 UL	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
N-Nitrosodiphenylamine	210	5 U	5 U	5.1 UJ	5 U	5 U	5 UL	5 U	5 U	5 U	5 U	5 UL	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Naphthalene	1.1	5 U	5 U	5.1 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 UL	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Pentachlorophenol	0.5	5 U	5 U	5.1 UJ	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 UL	5.0 U	5.0 U	5.0 U	5.0 U	10 U
Phenol	4	5 U	5 U	5.1 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 UL	5.0 U	5.0 U	5.0 U	5.0 U	10 U
Biological Oxygen Demand (mg/l)		--	--	5.9	7.2	1.8	2.5	< 2	10	12	--	--	--	--	--	--	--
Field Parameters																	
Temperature (Degrees Celcius)		15.8	--	16.8	30.9	13.1	7.1	17.0	33.2	28.8	7.4	28.2	13.6	18.1	17.5	15.1	21.0
Conductivity (µs/cm)		305	--	289	462	100	127	192	370	270	64	327	341	218	386	315	447
pH (standard units)	6.5 - 9	8.61	--	10.1	8.40	7.14	7.43	7.12	8.77	7.07	6.33	9.83	7.13	6.87	7.24	6.94	7.25
Dissolved Oxygen (mg/l)		8.29	--	11.63	7.92	5.74	8.54	6.20	10.28	8.92	6.84	9.29	8.41	5.23	10.18	6.72	3.66
ORP (mV)		63.9	--	68.8	50.6	80	149	32	84	84	39	2	61	100	-1	87	127

U - Analyte was not detected above the reporting limit.
J - Estimated concentration.
B - Analyte Detected in Method Blank
-- Not analyzed

D - Sample diluted in the lab for analysis.
K - Analyte present. May be biased High.
L - Analyte present. May be biased low
R - Data Rejected

1/16/2018

Attachment 6 (continued)

Summary of Surface-Water Quality Data for Army Creek and Army Pond

Parameter	BTAG Screening Level µg/l	SWC 10/04	1/05	4/05	7/05	10/05	1/06	4/06	7/06	10/06	1/07	4/07	10/09	10/10	10/11	10/12	10/17
***Dissolved Inorganics* (µg/l)**																	
Aluminum	87	4.4 U	--	38.1 U	53.6 U	15.1 U	54.6	43.2 U	48.2 U	20.0 U	30.3 U	102 U	200 U	200 U	200 U	200 U	200 U
Antimony	30	2 U	--	3.8 U	3.7 U	1.6 U	1.2 U	1.1 U	1.8 U	1.2 U	1.7 U	2.1 U	60.0 U	60.0 U	60.0 U	60.0 U	60.0 U
Arsenic	5	1.8 U	--	3 U	3.7 U	2 U	1.4 U	1.6 U	2.8 U	2.6 U	2.2 U	2.8 U	10.0 U	10.0 U	10.0 U	10.0 U	10 U
Barium	4	66.2	--	4.7	52.5	21.5	21.7	40.8	45.0	50.8	22.6	7.6	34.2 J	56.0 J	49.8 J	52.4 J	85.8 J
Beryllium	0.66	0.1 U	--	0.1 U	0.61 U	0.11 U	0.17 U	0.70 U	0.40 U	0.10 U	0.30 U	0.20 U	5.0 U	5.0 U	5.0 U	0.92 J	5.0 U
Cadmium	0.25	0.2 U	--	0.4 U	0.5 U	0.2 U	0.20 U	0.20 U	0.40 U	0.20 U	0.20 U	0.40 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Calcium	116000	19100	--	14500	15800	5820	5220	9830	16800	16300	6210	25800	16700	16000	23200	15100	22900
Chromium	85	0.5 U	--	1.2 U	1.1 U	0.6 U	0.40 U	0.60 U	0.50 U	0.42 U	0.60 U	0.30 U	10.0 U	10.0 U	10.0 U	10.0 U	10 U
Cobalt	23	50 U	--	1.1 U	1.1 U	0.5 U	0.62	0.88	0.70 U	0.93 U	1.6 U	1.1 U	50.0 U	50.0 U	50.0 U	50.0 U	1.1 J
Copper	9	0.5 U	--	0.9 U	0.8 U	0.6 U	1.6	0.40 U	1.5 U	3.2 U	0.86 U	3.8 U	25.0 U	25.0 U	0.88 J	25 U	25.0 U
Iron (mg/l)	0.3	0.226	0.322	0.363	0.499	0.0345	0.112	0.487	0.385	0.0618 U	0.537	0.760	0.188	0.300	0.114	0.403	0.240 K
Lead	2.5	0.9 U	--	1.2 U	1.6 U	1.1 U	1.0 U	1.0 U	1.9 U	1.6 U	1.2 U	2 U	10.0 U	10.0 U	10.0 U	10.0 U	10 U
Magnesium	82000	7080	--	4810	4550 J	4080	2940	4910	5550	6090	3390	8430	5280	5220	7730	5580	8110
Manganese (mg/l)	0.12	0.508	0.416	0.0347	0.0435	0.0269	0.0713	0.214	0.0551	0.0999	0.0553	0.0723	0.0325	0.157	0.0679	0.0943	0.363
Mercury	0.026	0.1 U	--	0.1 U	0.1 U	0.1 U	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
Nickel	52	0.5 U	--	2.7 U	1.8	3.9	1.2	2.2	1.4	2.3 U	2.4 U	3.8	40.0 U	40.0 U	40.0 U	1.4 J	40.0 U
Potassium	53000	3620	--	2480 J	4210 J	1830	1340	1980	4590	3350	1270	2410 J	3400 J	2620 J	2690 J	3210 J	5380
Selenium	1	2.6 U	--	1.7 U	4.5 U	4.3 U	3.3 U	1.8 U	2.2 U	2.5 U	2.1 U	2.7 U	35.0 U	35.0 U	35.0 U	35.0 U	35.0 U
Silver	3.2	0.7 U	--	1.4 U	1.3 U	0.2 U	0.50 U	0.50 U	0.30 U	0.51 U	0.40 U	1.2 U	10.0 U	10.0 U	10.0 U	10.0 U	10 U
Sodium	680000	25400	--	33400	32300	2880	6400	7720	21900	17900	2580	49000	24400	25700	39500	29600	57000
Thallium	0.8	1.9 U	--	2.9 U	4 U	4.5 U	3.9 U	2.1 U	3.6 U	3.2 U	3.4 U	2.9 U	25.0 U	25.0 U	25.0 U	25.0 U	25.0 U
Vanadium	20	50 U	--	1.7 U	2.7	0.5 U	0.53	0.40 U	2.1	0.46 U	0.40 U	4.2	50.0 U	50.0 U	50.0 U	50.0 U	50.0 U
Zinc	120	5.1	--	34.7	2.8 U	4	7.3	0.80 U	4.8 U	3.3	8.4 U	2.3 U	60.0 U	2.1 J	60.0 U	60.0 U	60.0 U
***Pesticides/Herbicides* (µg/l)**																	
4,4'-DDD		0.02 UJ	0.002 J	0.02 U	0.02 U	0.02 U	0.020 U	--	--	--	--	--	0.10 U	0.10 U	0.10 U	0.10 U	0.010 J
4,4'-DDE		0.02 UJ	0.0039 J	0.02 U	0.015 J	0.0047 J	0.020 U	--	--	--	--	--	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U
4,4'-DDT	0.0005	0.02 UJ	0.02 U	0.02 U	0.02 U	0.02 U	0.020 U	--	--	--	--	--	0.10 U	0.10 U	0.10 U	0.10 U	0.011 J
Aldrin	3	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.010 U	--	--	--	--	--	0.050 U	0.050 U	0.052 U	0.050 U	0.050 U
alpha-BHC		0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.010 U	--	--	--	--	--	0.050 U	0.050 U	0.052 U	0.050 U	0.050 U
Alpha-Chlordane		0.01 UJ	0.01 U	0.01 U	0.01 U	0.01 U	0.010 U	--	--	--	--	--	0.050 U	0.050 U	0.052 U	0.050 U	0.050 U
beta-BHC		0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.010 U	--	--	--	--	--	0.050 U	0.050 U	0.052 U	0.050 U	0.050 U
delta-BHC	141	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.010 U	--	--	--	--	--	0.050 U	0.050 U	0.052 U	0.050 U	0.050 U
Dieldrin	0.056	0.02 UJ	0.0025 J	0.02 U	0.02 U	0.02 U	0.020 U	--	--	--	--	--	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U
Endosulfan I	0.051	0.01 UJ	0.01 U	0.01 U	0.01 U	0.01 U	0.010 U	--	--	--	--	--	0.050 U	0.050 U	0.052 U	0.050 U	0.050 U
Endosulfan II	0.051	0.02 UJ	0.02 U	0.02 U	0.02 U	0.02 U	0.020 U	--	--	--	--	--	0.10 U	0.10 U	0.10 U	0.10 U	0.0064 K
Endosulfan sulfate		0.02 UJ	0.0016 J	0.02 U	0.02 U	0.02 U	0.020 U	--	--	--	--	--	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U
Endrin	0.036	0.02 UJ	0.02 U	0.02 U	0.02 U	0.02 U	0.020 U	--	--	--	--	--	0.10 U	0.10 U	0.10 U	0.10 U	0.012 J
Endrin Aldehyde		0.02 UJ	0.02 U	0.02 U	0.02 U	0.0025 J	0.020 U	--	--	--	--	--	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U
Endrin Ketone		0.02 UJ	0.02 U	0.02 U	0.02 U	0.02 U	0.020 U	--	--	--	--	--	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U
gamma-BHC (Lindane)	0.01	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.010 U	--	--	--	--	--	0.050 U	0.050 U	0.052 U	0.050 U	0.050 U
gamma-Chlordane		0.01 UJ	0.01 U	0.01 U	0.01 U	0.01 U	0.010 U	--	--	--	--	--	0.050 U	0.050 U	0.052 U	0.050 U	0.050 U
Heptachlor	0.0019	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.010 U	--	--	--	--	--	0.050 U	0.050 U	0.052 U	0.050 U	0.050 U
Heptachlor Epoxide		0.01 UJ	0.0022 J	0.012 JN	0.01 U	0.01 U	0.010 U	--	--	--	--	--	0.050 U	0.050 U	0.052 U	0.050 U	0.050 U
Methoxychlor	0.019	0.1 UJ	0.1 U	0.1 U	0.1 U	0.1 U	0.10 U	--	--	--	--	--	0.050 U	0.50 U	0.15 J	0.50 U	0.50 U
Toxaphene	0.0002	--	--	--	1 U	1 U	1.0 U	--	--	--	--	--	5.0 U	5.0 U	5.2 J	5.0 U	5.0 U

U - Analyte was not detected above the reporting limit.
J - Estimated concentration.
B - Analyte Detected in Method Blank
-- Not analyzed
N - Analysis indicates the presence of an analyte for which there is presumptive evidence to make a "tentative identification"

D - Sample diluted in the lab for analysis.
K - Analyte present. May be biased High.
L - Analyte present. May be biased low
R - Data Rejected
P - Discrepency in GC analysis. Lower value reported.

1/16/2018

Attachment 6 (continued)

Summary of Surface-Water Quality Data for Army Creek and Army Pond

Parameter	BTAG Screening Level µg/l	SWD 10/04	1/05	4/05	7/05	10/05	1/06	4/06	7/06	10/06	1/07	4/07	10/09	10/10	10/11	10/12	10/17
Non-Halogenated VOCs **(µg/l)**																	
Benzene	370	0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
Toluene	2	0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
Ethylbenzene	90	0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
Xylene (total)	13	0.5 U	5 U	5 U	5 U	5 UJ	10 U	3 U	3 U	3 U	3 U	3 U	--	--	--	--	--
2-Butanone	14000	5 U	10 U	10 R	10 R	10 UJ	10 U	5 U	5 U	5 U	5 U	5 U	--	--	--	--	--
Acetone	1500	5 U	20 R	20 R	20 R	20 R	10 U	5 UJ	9.7 U	5 U	5 UJ	5 U	--	--	--	--	--
Carbon Disulfide	0.92	0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
Cyclohexane		0.5 U	--	--	--	--	10 U	1 U	1 U	1 U	1 U	1 UJ	--	--	--	--	--
Isopropylbenzene	2.6	0.5 U	--	--	--	--	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
Methy-tert-butyl ether	11070	0.44 J	--	--	--	--	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
Methylcyclohexane		0.5 U	--	--	--	--	10 U	1 U	1 U	1 U	1 U	1 UJ	--	--	--	--	--
4-Methy-2-pentanone	170	5 U	10 U	10 U	10 U	10 UJ	10 U	5 U	5 U	5 U	5 U	5 U	--	--	--	--	--
Halogenated VOCs **(µg/l)**																	
Bromoform	320	0.5 U	5 U	5 U	5 U	5 UJ	10 UJ	1 U	1 U	1 U	1 U	1 UJ	--	--	--	--	--
Bromodichloromethane		0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
Carbon Tetrachloride	13.3	0.5 U	5 UJ	5 U	5 U	5 UJ	10 UJ	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
Chlorobenzene	1.3	0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
Chloroform	1.8	0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
Dibromochloromethane		0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
1,2-Dichloroethane	100	0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
1,1-Dichloroethane	47	0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
cis-1,2-Dichloroethene		0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
trans-1,2-Dichloroethene	970	0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
1,1-Dichloroethene	25	0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
1,2-Dichlorobenzene	0.7	0.5 U	--	--	--	--	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
1,3-Dichlorobenzene	150	0.5 U	--	--	--	--	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
1,4-Dichlorobenzene	26	0.5 U	--	--	--	--	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
Chloroethane		0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 R	1 U	1 U	1 U	1 U	--	--	--	--	--
Tetrachloroethene	111	0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
1,1,1-Trichloroethane	11	0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
Trichloroethene	21	0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
Vinyl Chloride	930	0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
1,2,4-Trichlorobenzene	24	0.5 U	--	--	--	--	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
cis-1,3-Dichloropropene		0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
Methylene Chloride	98.1	0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 U	1 UJ	1 UJ	1 U	1 U	--	--	--	--	--
Trichlorofluoromethane		0.5 U	--	--	--	--	10 U	1 UJ	1 U	1 U	1 U	1 U	--	--	--	--	--
Semi-Volatiles **(µg/l)**																	
1,1'-Biphenyl	14	5 U	5 U	5 U	5 UJ	5 U	5 U	5 U	5 U	5 UL	5 U	5 UL	5.1 U	5.0 U	5.0 U	5.0 U	5.0 U
2,2'-oxybis (1-Chloropropane)		5 UJ	5 U	5 U	5 UJ	5 U	5 UL	5 U	5 U	5 UL	5 U	5 UL	5.1 U	5.0 U	5.0 U	5.0 U	--
2,4-Dimethylphenol		5 U	5 U	5 U	5 UJ	5 U	5 U	5 U	5 U	5 UL	5 U	5 UL	5.1 U	5.0 U	5.0 U	5.0 U	5.0 U
2,4-Dinitrophenol		20 U	20 U	20 UJ	20 UJ	20 U	20 UL	20 U	20 UL	20 UL	20 U	20 UL	10 U	10 U	10 U	10 U	10 U
2,6-Dinitrotoluene	81	5 UJ	5 U	5 U	5 UJ	5 U	5 U	5 U	5 U	5 U	5 U	5 UL	5.1 U	5.0 U	5.0 U	5.0 U	5.0 U
2-Methylnaphthalene	4.7	5 U	5 U	5 U	5 UJ	5 U	5 U	5 U	5 U	5 U	5 U	5 UL	5.1 U	5.0 U	5.0 U	5.0 U	5.0 U
2-Methylphenol	13	5 U	5 U	5 U	5 UJ	5 U	5 U	5 U	5 U	5 UL	5 U	5 UL	5.1 U	5.0 U	5.0 U	5.0 U	10 U
4,6-Dinitro-2-methylphenol		20 U	20 U	20 U	20 UJ	20 U	20 UL	20 U	20 U	20 U	20 U	20 UL	10 U	10 U	10 U	10 U	10 U
4-Methylphenol	543	5 U	5 U	5 U	5 UJ	5 U	5 U	5 U	5 U	5 UL	5 U	5 UL	5.1 U	5.0 U	5.0 U	5.0 U	10 U
Acetophenone		5 U	5 U	5 U	5 UJ	5 U	5 U	5 U	5 U	5 U	5 U	5 UL	5.1 U	5.0 U	5.0 U	5.0 U	10 U
Atrazine	1.8	5 U	5 U	5 U	5 UL	5 U	5 UL	5 UL	5 U	5 UL	5 UL	5 UL	5.1 UJ	5.0 U	5.0 U	5.0 U	10 U
Benzaldehyde		5 UJ	5 U	5 UL	5 UL	5 U	5 U	5 UL	5 U	5 U	5 U	5 UL	5.1 UJ	5.0 UJ	5.0 U	5.0 U	10 U
Benzo (a) pyrene	0.015	5 U	5 UL	5 UL	5 UL	5 UL	5 UL	5 UL	5 UL	5 UL	5 UL	5 UL	5.1 U	5.0 U	5.0 U	5.0 U	5.0 U
Benzo (b) Fluoranthene		5 U	5 UL	5 UL	5 UL	5 UL	5 UL	5 UL	5 UL	5 UL	5 UL	5 UL	5.1 U	5.0 U	5.0 U	5.0 U	5.0 U
Benzo (g,h,i) Perylene		5 U	5 UL	5 UL	5 UL	5 UL	5 UL	5 UL	5 UL	5 UL	5 UL	5 UL	5.1 U	5.0 U	5.0 U	5.0 U	5.0 U
Benzo (k) Fluoranthene		5 U	5 UL	5 UL	5 UL	5 UL	5 UL	5 UL	5 UL	5 UL	5 UL	5 UL	5.1 U	5.0 U	5.0 U	5.0 U	5.0 U
Bis(2-chloroethyl)Ether		0.053	0.059	0.037	0.02 UJ	0.02 UL	5 U	5 U	5 U	5 UL	5 U	5 UL	5.1 U	5.0 U	5.0 U	5.0 U	10 U
Bis(2-ethylhexyl)phthalate	16	12	8.2	5 U	6.4 J	5 U	5 U	4.8 L	4.5 L	5 UL	4.8 L	5 UL	5.1 U	5.0 U	5.0 U	5.0 U	5.0 U
Caprolactam		5 UJ	5 U	5 U	5 UJ	5 U	5 UL	5 UL	5 UL	5 UL	5 UL	5 UL	5.1 U	5.0 UJ	5.0 U	5.0 U	10 U
Di-n-butyl phthalate	19	5 U	5 U	5 U	5 UJ	5 U	5 U	5 U	5 UL	5 UL	5 UL	5 UL	5.1 U	5.0 U	5.0 U	5.0 U	5.0 U
Di-n-octyl phthalate	22	5 U	5 U	5 U	5 UL	5 U	5 U	5 U	5 UL	5 UL	5 UL	5 UL	5.1 U	5.0 U	5.0 U	5.0 U	10 U
1,4-Dioxane		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2.0 U
Dibenzo (a,h) Anthracene		5 UJ	5 UL	5 UL	5 UL	5 UL	5 UL	5 UL	5 UL	5 UL	5 UL	5 UL	5.1 U	5.0 U	5.0 U	5.0 U	5.0 U
Diethylphthalate	210	5 U	5 U	5 U	5 UJ	5 U	5 UL	5 U	5 UL	5 UL	5 UL	5 UL	5.1 U	5.0 U	5.0 U	5.0 U	5.0 U
Hexachlorocyclopentadiene		5 U	5 U	5 U	5 UJ	5 U	5 UL	5 U	5 U	5 U	5 U	5 UL	5.1 U	5.0 R	5.0 U	5.0 U	10 U
Indeno (1,2,3-cd) Pyrene		5 UJ	5 UL	5 UL	5 UL	5 U	5 UL	5 UL	5 UL	5 UL	5 UL	5 UL	5.1 U	5.0 U	5.0 U	5.0 U	5.0 U
N-Nitrosodiphenylamine	210	5 U	5 U	5 UJ	5 UJ	5 U	5 UL	5 U	5 U	5 U	5 U	5 UL	5.1 U	5.0 U	5.0 U	5.0 U	5.0 U
Naphthalene	1.1	5 U	5 U	5 U	5 UJ	5 U	5 U	5 U	5 U	5 U	5 U	5 UL	5.1 U	5.0 U	5.0 U	5.0 U	5.0 U
Pentachlorophenol	0.5	5 U	5 U	5 UJ	5 UJ	5 U	5 U	5 U	5 U	5 UL	5 U	5 UL	5.1 U	5.0 U	5.0 U	5.0 U	10 U
Phenol	4	5 U	1.7 J	5 U	5 UJ	5 U	5 U	5 U	5 U	5 U	5 U	5 UL	5.1 U	5.0 U	5.0 U	5.0 U	10 U
Biological Oxygen Demand (mg/l)		--	--	1.5	5.3	3.3	6.3	5	6	5	--	--	--	--	--	--	--
Field Parameters																	
Temperature (Degrees Celcius)		17.52	--	14.19	24.8	11.9	7.4	16.3	28.5	19.1	6.4	19.6	12.1	16.2	17.1	12.9	20.8
Conductivity (µs/cm)		328	--	308	500	253	196	290	484	313	118	350	737	363	474	475	150
pH (standard units)	6.5 - 9	8.39	--	7.8	6.41	6.69	7.29	6.97	7.52	6.78	6.31	8.51	7.05	6.54	6.98	6.27	7.68
Dissolved Oxygen (mg/l)		4.04	--	7.54	2.46	4.51	10.50	6.91	5.95	7.04	8.81	8.15	4.21	0.00	2.95	3.25	5.07
ORP (mV)		-42.9	--	31.8	40.6	121	168	65	156	-11	34	58	1	8	-9	-182	106

U - Analyte was not detected above the reporting limit.
J - Estimated concentration.
B - Analyte Detected in Method Blank
-- Not analyzed

D - Sample diluted in the lab for analysis.
K - Analyte present. May be biased High.
L - Analyte present. May be biased low
R - Data Rejected

1/16/2018

Attachment 6 (continued)

Summary of Surface-Water Quality Data for Army Creek and Army Pond

Parameter	BTAG Screening Level µg/l	SWD 10/04	1/05	4/05	7/05	10/05	1/06	4/06	7/06	10/06	1/07	4/07	10/09	10/10	10/11	10/12	10/17
***Dissolved Inorganics* (µg/l)**																	
Aluminum	87	200 U	--	112 U	13.5 UJ	22.7 U	42.2 U	62.6 U	27.0 U	20.0 U	30.3 U	11.1 U	200 U	200 U	200 U	200 U	200 U
Antimony	30	2 U	--	32.7	3.7 UJ	1.6 U	1.2 U	1.1 U	1.8 U	1.4 J	1.7 U	2.1 I	60.0 U	60.0 U	60.0 U	60.0 U	60.0 U
Arsenic	5	1.8 U	--	7.1	3.7 UJ	2 U	1.4 U	1.6 U	2.8 U	2.6 U	2.2 U	2.8 U	10.0 U	10.0 U	10.0 U	10.0 U	10 U
Barium	4	66.1	--	172	65.7 J	65.7	47.1	40.4	63.9	56.1	33.2	76.5	72.8 J	89.8 J	85.3 J	76.4 J	32.8 J
Beryllium	0.66	0.1 U	--	2.7 U	0.6 UJ	0.13 U	0.18 U	0.74 U	0.54 U	0.10 U	0.30 U	0.20 U	5.0 U	5.0 U	5.0 U	0.89 J	5.0 U
Cadmium	0.25	0.2 U	--	2.5 U	0.5 UJ	0.2 U	0.20 U	0.20 U	0.40 U	0.20 U	0.20 U	0.40 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Calcium	116000	19500	--	21000	19200 J	16900	11300	12800	19900	18300	11800	22700	26500	23900	27300	22400	9030
Chromium	85	0.5 U	--	7.7 U	1.1 UJ	0.6 U	0.40 U	0.64	0.50 U	0.52 U	0.60 U	0.30 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U
Cobalt	23	50 U	--	27.1	1.1 UJ	0.5 U	0.50 U	0.40 U	1.5	0.96 U	0.40 U	0.90 U	50.0 U	1.6 J	50.0 U	50.0 U	50.0 U
Copper	9	0.5 U	--	13	0.8 UJ	2.5	1.3	2.4 U	1.5 U	3.7 U	2.8 U	1.4 U	25.0 U	25.0 U	1.2 J	25 U	25 U
Iron (mg/l)	0.3	1.17	10.1	0.422	0.743 J	0.0371	0.0952 U	0.338	0.0413 U	0.730	0.396	0.403	0.787	0.758	0.726	0.388	0.172 K
Lead	2.5	0.9 U	--	2.3	1.6 UJ	1.1 U	1.0 U	1.0 U	1.9 U	1.6 U	1.2 U	1.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10 U
Magnesium	82000	7390	--	8440	241 J	5960	5100	4510	7390	7180	4420	9200	10800	9360	10400	8800	3230 J
Manganese (mg/l)	0.12	0.368	1.99	0.352	7.15 J	0.0158	0.0244	0.0850	0.217	0.209	0.0745	0.243	0.382	0.262	0.291	0.246	0.0681
Mercury	0.026	0.2 U	--	0.1 U	0.1 UJ	0.1 U	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
Nickel	52	0.68	--	25.1 U	2.2 J	2.7	2	2.1	1.3	2.1 U	1.7 U	2.2	40.0 U	2.3 J	40.0 U	2.5 J	40.0 U
Potassium	53000	3440	--	3860 J	4790 J	4290	4110	3460	4670	3770	2720	2920 J	4870 J	3360 J	3240 J	4400 J	4000 J
Selenium	1	2.6 U	--	4.4 U	4.5 UJ	4.3 U	3.3 U	1.8 U	2.2 U	2.5 U	2.1 U	2.7 U	35.0 U	35.0 U	35.0 U	35.0 U	35.0 U
Silver	3.2	0.7 U	--	5.1	1.3 UJ	0.2 U	0.50 U	0.50 U	0.30 U	0.50 U	0.40 U	1.2 U	10.0 U	10.0 U	10.0 U	10.0 U	10 U
Sodium	680000	28600	--	49400	41500 J	15400	7090	20100	28600	23000	12600	53100	66300	46900	46000	43300	12800
Thallium	0.8	1.9 U	--	6.4 U	4 UJ	4.5 U	4	2.1 U	3.6 U	3.2 U	3.4 U	2.9 U	25.0 U	25.0 U	25.0 U	25.0 U	25.0 U
Vanadium	20	50 U	--	25.8	0.8 UJ	0.5 U	0.30 U	0.62 U	0.30 U	0.40 U	0.46 U	0.50 U	50.0 U	50.0 U	50.0 U	50.0 U	50.0 U
Zinc	120	7.6	--	22.3 U	10.3 UJ	29.3	11.4	10.2	8.3 U	6.7	11.9 U	10.7	60.0 U	11.3 J	8.4 J	60 U	10.0 J
***Pesticides/Herbicides* (µg/l)**																	
4,4'-DDD		0.02 UJ	0.026	0.02 U	0.02 UJ	0.02 U	0.020 U	--	--	--	--	--	0.10 U	0.10 U	0.11 U	0.10 U	0.10 U
4,4'-DDE		0.02 UJ	0.036	0.02 U	0.02 UJ	0.0075 J	0.020 U	--	--	--	--	--	0.10 U	0.10 U	0.11 U	0.10 U	0.10 U
4,4'-DDT	0.0005	0.02 UJ	0.02 U	0.02 U	0.02 UJ	0.02 U	0.020 U	--	--	--	--	--	0.10 U	0.10 U	0.11 U	0.10 U	0.10 U
Aldrin	3	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.010 U	--	--	--	--	--	0.050 U	0.050 U	0.053 U	0.050 U	0.050 U
alpha-BHC		0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.010 U	--	--	--	--	--	0.050 U	0.050 U	0.053 U	0.050 U	0.050 U
Alpha-Chlordane		0.01 UJ	0.046 JN	0.01 U	0.01 UJ	0.01 U	0.010 U	--	--	--	--	--	0.050 U	0.050 U	0.053 U	0.050 U	0.050 U
beta-BHC		0.01 U	0.01 U	0.01 U	0.024 JN	0.01 U	0.010 U	--	--	--	--	--	0.050 U	0.050 U	0.053 U	0.050 U	0.050 U
delta-BHC	141	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.010 U	--	--	--	--	--	0.050 U	0.050 U	0.053 U	0.050 U	0.050 U
Dieldrin	0.056	0.02 UJ	0.02 U	0.0044 J	0.02 UJ	0.02 U	0.020 U	--	--	--	--	--	0.10 U	0.10 U	0.11 U	0.10 U	0.10 U
Endosulfan I	0.051	0.01 UJ	0.01 U	0.01 U	0.01 UJ	0.01 U	0.010 U	--	--	--	--	--	0.050 U	0.050 U	0.053 U	0.050 U	0.050 U
Endosulfan II	0.051	0.02 UJ	0.02 U	0.02 U	0.02 UJ	0.02 U	0.020 U	--	--	--	--	--	0.10 U	0.10 U	0.11 U	0.10 U	0.10 U
Endosulfan sulfate		0.02 UJ	0.03	0.02 U	0.02 UJ	0.02 U	0.020 U	--	--	--	--	--	0.10 U	0.10 U	0.11 U	0.10 U	0.0048 J
Endrin	0.036	0.02 UJ	0.02 U	0.02 U	0.02 UJ	0.02 U	0.020 U	--	--	--	--	--	0.10 U	0.10 U	0.11 U	0.10 U	0.10 U
Endrin Aldehyde		0.02 UJ	0.02 U	0.02 U	0.02 UJ	0.02 U	0.020 U	--	--	--	--	--	0.10 U	0.10 U	0.11 U	0.10 U	0.023 J
Endrin Ketone		0.02 UJ	0.02 U	0.02 U	0.02 UJ	0.02 U	0.020 U	--	--	--	--	--	0.10 U	0.10 U	0.11 U	0.10 U	0.10 U
gamma-BHC (Lindane)	0.01	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.010 U	--	--	--	--	--	0.050 U	0.050 U	0.053 U	0.050 U	0.050 U
gamma-Chlordane		0.01 UJ	0.038 JN	0.01 U	0.01 UJ	0.01 U	0.010 U	--	--	--	--	--	0.050 U	0.050 U	0.053 U	0.050 U	0.050 U
Heptachlor	0.0019	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.010 U	--	--	--	--	--	0.050 U	0.050 U	0.053 U	0.050 U	0.050 U
Heptachlor Epoxide		0.01 UJ	0.01 J	0.011 JN	0.061 J	0.01 U	0.010 U	--	--	--	--	--	0.050 U	0.050 U	0.053 U	0.050 U	0.050 U
Methoxychlor	0.019	0.1 UJ	0.1 U	0.1 U	0.1 UJ	0.1 U	0.10 U	--	--	--	--	--	0.050 U	0.50 U	0.53 U	0.50 U	0.50 U
Toxaphene	0.0002	--	--	--	1 UJ	1 U	1.0 U	--	--	--	--	--	5.0 U	5.0 U	5.3 U	5.0 U	5.0 U

U - Analyte was not detected above the reporting limit.
J - Estimated concentration.
B - Analyte Detected in Method Blank
-- Not analyzed
N - Analysis indicates the presence of an analyte for which there is presumptive evidence to make a "tentative identification"

D - Sample diluted in the lab for analysis.
K - Analyte present. May be biased High.
L - Analyte present. May be biased low
R - Data Rejected
P - Discrepency in GC analysis. Lower value reported.

1/16/2018

Attachment 6 (continued)

Summary of Surface-Water Quality Data for Army Creek and Army Pond

Parameter	BTAG Screening Level µg/l	SWE 10/04	1/05	4/05	7/05	10/05	1/06	4/06	7/06	10/06	1/07	4/07	10/09	10/10	10/11	10/12	10/17
Non-Halogenated VOCs **(µg/l)**																	
Benzene	370	0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
Toluene	2	0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
Ethylbenzene	90	0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
Xylene (total)	13	0.5 U	5 U	5 U	5 U	5 UJ	10 U	3 U	3 U	3 U	3 U	3 U	--	--	--	--	--
2-Butanone	14000	5 U	10 U	10 R	10 R	10 UJ	10 U	5 U	5 U	5 U	5 U	5 U	--	--	--	--	--
Acetone	1500	5 U	20 R	20 R	20 R	20 R	1.6 J	5 UJ	8.4 U	5 U	5 UJ	5 U	--	--	--	--	--
Carbon Disulfide	0.92	0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
Cyclohexane		0.5 U	--	--	--	--	10 U	1 U	1 U	1 U	1 U	1 UJ	--	--	--	--	--
Isopropylbenzene	2.6	0.5 U	--	--	--	--	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
Methy-tert-butyl ether	11070	0.34 J	--	--	--	--	10 U	0.57 J	1 U	1 U	1 U	1 U	--	--	--	--	--
Methylcyclohexane		0.5 U	--	--	--	--	10 U	1 U	1 U	1 U	1 U	1 UJ	--	--	--	--	--
4-Methy-2-pentanone	170	5 U	10 U	10 U	10 U	10 UJ	10 U	5 U	5 U	5 U	5 U	5 U	--	--	--	--	--
Halogenated VOCs **(µg/l)**																	
Bromoform	320	0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 U	1 UJ	1 U	1 U	1 UJ	--	--	--	--	--
Bromodichloromethane		0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
Carbon Tetrachloride	13.3	0.5 U	5 UJ	5 U	5 U	5 UJ	10 UJ	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
Chlorobenzene	1.3	0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
Chloroform	1.8	0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
Dibromochloromethane		0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
1,2-Dichloroethane	100	0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
1,1-Dichloroethane	47	0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
cis-1,2-Dichloroethene		0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
trans-1,2-Dichloroethene	970	0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
1,1-Dichloroethene	25	0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
1,2-Dichlorobenzene	0.7	0.5 U	--	--	--	--	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
1,3-Dichlorobenzene	150	0.5 U	--	--	--	--	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
1,4-Dichlorobenzene	26	0.5 U	--	--	--	--	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
Chloroethane		0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 R	1 U	1 U	1 U	1 U	--	--	--	--	--
Tetrachloroethene	111	0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
1,1,1-Trichloroethane	11	0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
Trichloroethene	21	0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
Vinyl Chloride	930	0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
1,2,4-Trichlorobenzene	24	0.5 U	--	--	--	--	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
cis-1,3-Dichloropropene		0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
Methylene Chloride	98.1	0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 U	1 UJ	1 UJ	1 U	1 U	--	--	--	--	--
Trichlorofluoromethane		0.5 U	--	--	--	--	10 U	1 UJ	1 U	1 U	1 U	1 U	--	--	--	--	--
Semi-Volatiles **(µg/l)**																	
1,1'-Biphenyl	14	5 U	5 UL	5 U	5.3 UJ	5 U	5 U	5 U	5 U	5 UL	5 U	5 UL	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
2,2'-oxybis (1-Chloropropane)		5 UJ	5 U	5 U	5.3 UJ	5 U	5 UL	5 U	5 U	5 UL	5 U	5 UL	5.0 U	5.0 U	5.0 U	5.0 U	--
2,4-Dimethylphenol		5 U	5 U	5 U	5.3 UJ	5 U	5 U	5 U	5 U	5 UL	5 U	5 UL	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
2,4-Dinitrophenol		20 U	20 U	20 UJ	21 UJ	20 U	20 UL	20 U	20 UL	20 UL	20 U	20 UL	10 U	10 U	10 U	10 U	10 U
2,6-Dinitrotoluene	81	5 UJ	5 U	5 U	5.3 UJ	5 U	5 U	5 U	5 U	5 U	5 U	5 UL	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
2-Methylnaphthalene	4.7	5 U	5 U	5 U	5.3 UJ	5 U	5 U	5 U	5 U	5 UL	5 U	5 UL	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
2-Methylphenol	13	5 U	5 U	5 U	5.3 UJ	5 U	5 U	5 U	5 U	5 UL	5 U	5 UL	5.0 U	5.0 U	5.0 U	5.0 U	10 U
4,6-Dinitro-2-methylphenol		20 U	20 U	20 U	21 UJ	20 U	20 UL	20 U	20 U	20 U	20 U	20 UL	10 U	10 U	10 U	10 U	10 U
4-Methylphenol	543	5 U	5 U	5 U	5.3 UJ	5 U	5 U	5 U	5 U	5 UL	5 U	5 UL	5.0 U	5.0 U	5.0 U	5.0 U	10 U
Acetophenone		5 U	5 U	5 U	5.3 UJ	5 U	5 U	5 U	5 U	5 U	5 U	5 UL	5.0 U	5.0 U	5.0 U	5.0 U	10 U
Atrazine	1.8	5 U	5 U	5 U	5.3 UL	5 U	5 UL	5 UL	5 U	5 UL	5 U	5 UL	5.0 UJ	5.0 U	5.0 U	5.0 U	10 U
Benzaldehyde		5 UJ	5 U	5 UL	5.3 UL	5 U	5 U	5 UL	5 U	5 U	5 U	5 UL	5.0 UJ	5.0 UJ	5.0 U	5.0 U	10 U
Benzo (a) pyrene	0.015	5 UL	5 UL	5 U	5.3 UL	5 U	5 UL	5 UL	5 UL	5 UL	5 UL	5 UL	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Benzo (b) Fluoranthene		5 UL	5 UL	5 U	5.3 UL	5 U	5 UL	5 UL	5 UL	5 UL	5 UL	5 UL	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Benzo (g,h,i) Perylene		5 UL	5 UL	5 U	5.3 UL	5 U	5 UL	5 UL	5 UL	5 UL	5 UL	5 UL	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Benzo (k) Fluoranthene		5 UL	5 UL	5 U	5.3 UL	5 U	5 UL	5 UL	5 UL	5 UL	5 UL	5 UL	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Bis(2-chloroethyl)Ether		0.021	0.025	0.043	0.021 UJ	0.02 UL	5 U	5 U	5 U	5 UL	5 U	5 UL	5.0 U	5.0 U	5.0 U	5.0 U	10 U
Bis(2-ethylhexyl)phthalate	16	5 U	5 U	48	4.6 J	5 U	5 U	5 UL	5 UL	5 UL	5 U	5 UL	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Caprolactam		5 UJ	5 UL	5 U	5.3 UJ	5 U	5 UL	5 UL	5 UL	5 UL	5 U	5 UL	5.0 U	5.0 UJ	5.0 U	5.0 U	10 U
Di-n-butyl phthalate	19	5 U	5 UL	5 U	5.3 UJ	5 U	5 U	5 U	5 UL	5 UL	5 U	5 UL	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Di-n-octyl phthalate	22	5 U	5 UL	5 U	5.3 UL	5 U	5 U	5 U	5 UL	5 UL	5 U	5 UL	5.0 U	5.0 U	5.0 U	5.0 U	10 U
1,4-Dioxane		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2.0 U
Dibenzo (a,h) Anthracene		5 UL	5 UL	5 U	5.3 UL	5 U	5 UL	5 UL	5 UL	5 UL	5 UL	5 UL	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Diethylphthalate	210	5 U	5 UL	5 U	5.3 UJ	5 U	5 UL	5 U	5 UL	5 UL	5 U	5 UL	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Hexachlorocyclopentadiene		5 U	5 U	5 U	5.3 UJ	5 U	5 UL	5 U	5 U	5 U	5 U	5 UL	5.0 U	5.0 R	5.0 U	5.0 U	10 U
Indeno (1,2,3-cd) Pyrene		5 UL	5 UL	5 U	5.3 UL	5 U	5 UL	5 UL	5 UL	5 UL	5 UL	5 UL	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
N-Nitrosodiphenylamine	210	5 U	5 U	5 UJ	5.3 UJ	5 U	5 UL	5 U	5 U	5 U	5 U	5 UL	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Naphthalene	1.1	5 U	5 U	5 U	5.3 UJ	5 U	5 U	5 U	5 U	5 UL	5 U	5 UL	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Pentachlorophenol	0.5	5 U	5 U	5 UJ	5.3 UJ	5 U	5 U	5 U	5 U	5 UL	5 U	5 UL	5.0 U	5.0 U	5.0 U	5.0 U	10 U
Phenol	4	5 U	5 U	5 U	5.3 UJ	5 U	5 U	5 U	5 U	5 U	5 U	5 UL	5.0 U	5.0 U	5.0 U	5.0 U	10 U
Biological Oxygen Demand (mg/l)		--	--	1.1	5.8	1.6	3.4	< 2	5	5	--	--	--	--	--	--	--
Field Parameters																	
Temperature (Degrees Celcius)		14.58	--	11.5	25.2	12.1	7.3	16.0	25.9	21.2	6.7	19.5	12.8	16.6	17.2	13.1	21.2
Conductivity (µs/cm)		288	--	309	507	308	117	288	477	303	121	352	701	304	442	472	126
pH (standard units)	6.5 - 9	8.35	--	8.07	6.56	6.92	7.44	6.97	7.02	6.84	6.72	8.27	7.15	6.57	7.07	6.35	7.50
Dissolved Oxygen (mg/l)		4.95	--	7.69	5.18	5.89	8.73	6.82	5.85	7.31	9.10	10.10	5.28	0.00	3.71	2.84	4.39
ORP (mV)		35.1	--	93.3	108.3	36	160	98	151	54	51	81	29	42	61	76	138

U - Analyte was not detected above the reporting limit.
J - Estimated concentration.
B - Analyte Detected in Method Blank
-- Not analyzed

D - Sample diluted in the lab for analysis.
K - Analyte present. May be biased High.
L - Analyte present. May be biased low
R - Data Rejected

1/16/2018

Attachment 6 (continued)

Summary of Surface-Water Quality Data for Army Creek and Army Pond

Parameter	BTAG Screening Level µg/l	SWE 10/04	1/05	4/05	7/05	10/05	1/06	4/06	7/06	10/06	1/07	4/07	10/09	10/10	10/11	10/12	10/17
***Dissolved Inorganics* (µg/l)**																	
Aluminum	87	200 U	--	11.9 U	15.6 UJ	10.9 U	48.3 U	50.6 U	22.4 U	20.0 U	65.3 U	11.1 U	200 U	200 U	200 U	200 U	200 U
Antimony	30	2 U	--	3.8 U	3.7 UJ	1.6 U	1.2 U	1.1 U	1.8 U	1.2 U	1.7 U	2.1 U	60.0 U	60.0 U	60.0 U	5.7 J	60.0 U
Arsenic	5	1.8 U	--	3 U	3.7 UJ	2 U	1.4 U	1.6 U	2.8 U	2.6 U	2.2 U	2.8 U	2.3 J	2.9 J	10.0 U	10.0 U	10.0 U
Barium	4	61	--	71.5	57.9 J	58	20.5	40.9	59.2	51.3	34.2	73.2	68.5 J	80.9 J	78.1 J	76.7 J	27.1 J
Beryllium	0.66	0.1 U	--	0.1 U	0.62 UJ	0.11 U	0.16 U	0.64 U	0.45 U	0.10 U	0.47 U	0.20 U	5.0 U	5.0 U	5.0 U	0.86 J	5.0 U
Cadmium	0.25	0.2 U	--	0.4 U	0.5 UJ	0.2 U	0.20 U	0.20 U	0.40 U	0.20 U	0.20 U	0.40 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Calcium	116000	20200	--	21400	18500 J	17800	6280	13300	19200	19500	12300	22100	26900	20700	22800	23500	8150
Chromium	85	0.5 U	--	1.5 U	1.1 UJ	0.6 U	0.43 U	0.60 U	0.50 U	0.52 U	0.60 U	0.30 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U
Cobalt	23	50 U	--	1.3 U	1.1 UJ	0.5 U	0.50 U	0.46	0.93	1.4 U	0.62 U	0.90 U	50.0 U	2.5 J	50.0 U	50.0 U	50.0 U
Copper	9	0.5 U	--	0.9 U	1.1 J	1.3	1.8	2.5 U	1.5 U	3.5 U	3.1 U	1.6 U	25.0 U	25.0 U	2.2 J	25 U	25 U
Iron (mg/l)	0.3	0.011 U	1.06	0.335	0.139 UJ	0.122	0.108	0.310	0.0124 U	0.141	0.324	0.0586 U	0.100 U	0.249	0.239	0.100 U	0.101 K
Lead	2.5	0.9 U	--	1.2 U	1.6 UJ	1.1 U	1.0 U	1.0 U	1.9 U	1.6 U	1.2 U	1.3 U	10.0 U	10.0 U	10.0 U	10.0 U	10 U
Magnesium	82000	7660	--	8600	6960 J	6760	2870	4660	7220	7270	4660	8970	11200	7700	9400	9160	2820 J
Manganese (mg/l)	0.12	0.236	0.288	0.309	0.177 J	0.148	0.0246	0.103	0.144	0.423	0.0814	0.224	0.239	1.22	0.157	0.272	0.0458
Mercury	0.026	0.1 U	--	0.1 U	0.1 UJ	0.1 U	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
Nickel	52	0.5 U	--	3.1 U	2.4 J	3.3	1.5	2.5	1.4	2.8 U	2.0 U	2.2	40.0 U	2.8 J	40.0 U	3.0 J	40.0 U
Potassium	53000	3730	--	3530 J	4610 J	4330	1990	3430	4600	3160	2790	2710 J	5140 J	3000 J	3250 J	4930 J	2690 J
Selenium	1	2.6 U	--	2.3 U	4.5 UJ	4.3 U	3.3 U	1.8 U	2.2 U	2.5 U	2.1 U	2.7 U	35.0 U	35.0 U	35.0 U	35.0 U	35.0 U
Silver	3.2	0.7 U	--	1.4 U	1.3 UJ	0.2 U	0.50 U	0.50 U	0.30 U	0.59 U	0.40 U	1.2 U	10.0 U	10.0 U	10.0 U	10.0 U	10 U
Sodium	680000	30300	--	54600	41500 J	22300	6050	20600	30300	21400	13200	52900	65600	35300	40200	41500	11000
Thallium	0.8	1.9 U	--	2.9 U	4 UJ	4.5 U	3.9 U	2.1 U	3.6 U	3.2 U	3.4 U	2.9 U	25.0 U	25.0 U	25.0 U	25.0 U	25.0 U
Vanadium	20	0.4 U	--	1 U	0.8 UJ	0.5 U	0.31	0.74 U	0.30 U	0.40 U	0.81 U	0.50 U	50.0 U	50.0 U	50.0 U	50.0 U	50.0 U
Zinc	120	8.1	--	14.3 U	8.3 UJ	15.5	9.2	11.8	9.7 U	7.1	13.1 U	10	60.0 U	10.1 J	9.6 J	60 U	10.2 J
***Pesticides/Herbicides* (µg/l)**																	
4,4'-DDD		0.02 UJ	0.02 U	0.02 U	0.02 UJ	0.002 J	0.020 U	--	--	--	--	--	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U
4,4'-DDE		0.02 UJ	0.02 U	0.02 U	0.0027 JN	0.01 J	0.020 U	--	--	--	--	--	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U
4,4'-DDT	0.0005	0.02 UJ	0.02 U	0.02 U	0.02 UJ	0.02 U	0.020 U	--	--	--	--	--	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U
Aldrin	3	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.010 U	--	--	--	--	--	0.050 U	0.050 U	0.050 U	0.050 U	0.050 U
alpha-BHC		0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.010 U	--	--	--	--	--	0.050 U	0.050 U	0.050 U	0.050 U	0.050 U
Alpha-Chlordane		0.01 UJ	0.01 U	0.01 U	0.01 UJ	0.0049 J	0.010 U	--	--	--	--	--	0.050 U	0.050 U	0.050 U	0.050 U	0.050 U
beta-BHC		0.01 U	0.01 U	0.01 U	0.017 J	0.01 U	0.010 U	--	--	--	--	--	0.050 U	0.050 U	0.050 U	0.050 U	0.050 U
delta-BHC	141	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.010 U	--	--	--	--	--	0.050 U	0.050 U	0.050 U	0.050 U	0.050 U
Dieldrin	0.056	0.02 UJ	0.02 U	0.0068 J	0.02 UJ	0.0073 J	0.020 U	--	--	--	--	--	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U
Endosulfan I	0.051	0.01 UJ	0.01 U	0.01 U	0.01 UJ	0.01 U	0.0014 J	--	--	--	--	--	0.050 U	0.050 U	0.050 U	0.050 U	0.050 U
Endosulfan II	0.051	0.02 UJ	0.02 U	0.02 U	0.02 UJ	0.02 U	0.020 U	--	--	--	--	--	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U
Endosulfan sulfate		0.02 UJ	0.02 U	0.02 U	0.02 UJ	0.0073 J	0.020 U	--	--	--	--	--	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U
Endrin	0.036	0.02 UJ	0.02 U	0.02 U	0.02 UJ	0.02 U	0.020 U	--	--	--	--	--	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U
Endrin Aldehyde		0.02 UJ	0.02 U	0.02 U	0.02 UJ	0.02 U	0.020 U	--	--	--	--	--	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U
Endrin Ketone		0.02 UJ	0.02 U	0.02 U	0.02 UJ	0.02 U	0.020 U	--	--	--	--	--	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U
gamma-BHC (Lindane)	0.01	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.010 U	--	--	--	--	--	0.050 U	0.050 U	0.050 U	0.050 U	0.050 U
gamma-Chlordane		0.01 UJ	0.01 U	0.01 U	0.01 UJ	0.01 U	0.010 U	--	--	--	--	--	0.050 U	0.050 U	0.050 U	0.050 U	0.050 U
Heptachlor	0.0019	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.010 U	--	--	--	--	--	0.050 U	0.050 U	0.050 U	0.050 U	0.050 U
Heptachlor Epoxide		0.01 UJ	0.01 U	0.016 JN	0.01 UJ	0.01 U	0.010 U	--	--	--	--	--	0.050 U	0.050 U	0.050 U	0.050 U	0.050 U
Methoxychlor	0.019	0.1 UJ	0.1 U	0.1 U	0.1 UJ	0.1 U	0.10 U	--	--	--	--	--	0.050 U	0.50 U	0.50 U	0.50 U	0.50 U
Toxaphene	0.0002	--	--	--	1 UJ	1 U	1.0 U	--	--	--	--	--	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U

U - Analyte was not detected above the reporting limit.
J - Estimated concentration.
B - Analyte Detected in Method Blank
-- Not analyzed
N - Analysis indicates the presence of an analyte for which there is presumptive evidence to make a "tentative identification"

D - Sample diluted in the lab for analysis.
K - Analyte present. May be biased High.
L - Analyte present. May be biased low
R - Data Rejected
P - Discrepency in GC analysis. Lower value reported.

1/16/2018

Attachment 6 (continued)

Summary of Surface-Water Quality Data for Army Creek and Army Pond

Parameter	BTAG Screening Level µg/l	SWF 10/04	1/05	4/05	7/05	10/05	1/06	4/06	7/06	10/06	1/07	4/07	10/09	10/10	10/11	10/12	10/17
Non-Halogenated VOCs **(µg/l)**																	
Benzene	370	0.14 J	5 U	5 U	5 U	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
Toluene	2	0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
Ethylbenzene	90	0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
Xylene (total)	13	0.5 U	5 U	5 U	5 U	5 UJ	10 U	3 U	3 U	3 U	3 U	3 U	--	--	--	--	--
2-Butanone	14000	5 U	10 U	10 R	10 R	10 UJ	10 U	5 U	5 U	5 U	5 U	5 U	--	--	--	--	--
Acetone	1500	5 U	20 R	20 R	20 R	20 R	10 U	5 UJ	6.0 U	5 U	5 UJ	5 U	--	--	--	--	--
Carbon Disulfide	0.92	0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
Cyclohexane		0.5 U	--	--	--	--	10 U	1 U	1 U	1 U	1 U	1 UJ	--	--	--	--	--
Isopropylbenzene	2.6	0.5 U	--	--	--	--	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
Methy-tert-butyl ether	11070	0.5 J	--	--	--	--	10 U	0.42 J	1 U	1 U	1 U	1 U	--	--	--	--	--
Methylcyclohexane		0.5 U	--	--	--	--	10 U	1 U	1 U	1 U	1 U	1 UJ	--	--	--	--	--
4-Methy-2-pentanone	170	5 U	10 U	10 U	10 UJ	10 UJ	10 U	5 U	5 U	5 U	5 U	5 U	--	--	--	--	--
Halogenated VOCs **(µg/l)**																	
Bromoform	320	0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 U	1 U	1 U	1 U	1 UJ	--	--	--	--	--
Bromodichloromethane		0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
Carbon Tetrachloride	13.3	0.5 U	5 UJ	5 U	5 U	5 UJ	10 UJ	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
Chlorobenzene	1.3	0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
Chloroform	1.8	0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
Dibromochloromethane		0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
1,2-Dichloroethane	100	0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
1,1-Dichloroethane	47	0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
cis-1,2-Dichloroethene		0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
trans-1,2-Dichloroethene	970	0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
1,1-Dichloroethene	25	0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
1,2-Dichlorobenzene	0.7	0.5 U	--	--	--	--	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
1,3-Dichlorobenzene	150	0.5 U	--	--	--	--	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
1,4-Dichlorobenzene	26	0.5 U	--	--	--	--	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
Chloroethane		0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 R	1 U	1 U	1 U	1 U	--	--	--	--	--
Tetrachloroethene	111	0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
1,1,1-Trichloroethane	11	0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
Trichloroethene	21	0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
Vinyl Chloride	930	0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
1,2,4-Trichlorobenzene	24	0.5 U	--	--	--	--	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
cis-1,3-Dichloropropene		0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
Methylene Chloride	98.1	0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 U	1 UJ	1 UJ	1 U	1 U	--	--	--	--	--
Trichlorofluoromethane		0.5 U	--	--	--	--	10 U	1 UJ	1 U	1 U	1 U	1 U	--	--	--	--	--
Semi-Volatiles **(µg/l)**																	
1,1'-Biphenyl	14	5 U	5 UL	5 U	5 UJ	5 U	5 U	5 U	5 U	5 UL	5 U	5 UL	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
2,2'-oxybis (1-Chloropropane)		5 U	5 U	5 U	5 UJ	5 U	5 UL	5 U	5 U	5 UL	5 U	5 UL	5.0 U	5.0 U	5.0 U	5.0 U	--
2,4-Dimethylphenol		5 U	5 U	5 U	5 UJ	5 U	5 U	5 U	5 U	5 U	5 U	5 UL	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
2,4-Dinitrophenol		20 U	20 U	20 UJ	20 UJ	20 U	20 UL	20 U	20 UL	20 U	20 U	20 UL	10 U	10 U	10 U	10 U	10 U
2,6-Dinitrotoluene	81	5 UJ	5 U	5 U	5 UJ	5 U	5 U	5 U	5 U	5 U	5 U	5 UL	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
2-Methylnaphthalene	4.7	5 U	5 U	5 U	5 UJ	5 U	5 U	5 U	5 U	5 U	5 U	5 UL	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
2-Methylphenol	13	5 U	5 U	5 U	5 UJ	5 U	5 U	5 U	5 U	5 U	5 U	5 UL	5.0 U	5.0 U	5.0 U	5.0 U	10 U
4,6-Dinitro-2-methylphenol		20 U	20 U	20 U	20 UJ	20 U	20 UL	20 U	20 U	20 U	20 U	20 UL	10 U	10 U	10 U	10 U	10 U
4-Methylphenol	543	5 U	5 U	5 U	5 UJ	5 U	5 U	5 U	5 U	5 U	5 U	5 UL	5.0 U	5.0 U	5.0 U	5.0 U	10 U
Acetophenone		5 U	5 U	5 U	5 UJ	5 U	5 U	5 U	5 U	5 U	5 U	5 UL	5.0 U	5.0 U	5.0 U	5.0 U	10 U
Atrazine	1.8	5 U	5 U	5 U	5 UL	5 UJ	5 UL	5 UL	5 U	5 UL	5 U	5 UL	5.0 UJ	5.0 U	5.0 U	5.0 U	10 U
Benzaldehyde		5 UJ	5 U	5 UL	5 UL	5 U	5 U	5 UL	5 U	5 U	5 U	5 UL	5.0 UJ	5.0 UJ	5.0 U	5.0 U	10 U
Benzo (a) pyrene	0.015	5 U	5 U	5 UL	5 UJ	5 U	5 UL	5 UL	5 UL	5 UL	5 UL	5 UL	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Benzo (b) Fluoranthene		5 U	5 U	5 UL	5 UJ	5 U	5 UL	5 UL	5 UL	5 UL	5 UL	5 UL	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Benzo (g,h,i) Perylene		5 U	5 U	5 UL	5 UJ	5 U	5 UL	5 UL	5 UL	5 UL	5 UL	5 UL	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Benzo (k) Fluoranthene		5 U	5 U	5 UL	5 UJ	5 U	5 UL	5 UL	5 UL	5 UL	5 UL	5 UL	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Bis(2-chloroethyl)Ether		0.019 U	0.69	0.037	0.02 UJ	0.02 UL	5 U	5 U	5 U	5 UL	5 U	5 UL	5.0 U	5.0 U	5.0 U	5.0 U	10 U
Bis(2-ethylhexyl)phthalate	16	5 U	5 U	5 U	16 J	5 U	5 U	5 UL	5 UL	5 UL	5 UL	5 UL	6.5	6.5	5.0 U	5.0 U	5.0 U
Caprolactam		5 UJ	5 UL	5 U	5 UJ	5 U	5 UL	5 UL	5 UL	5 UL	2.3 L	5 UL	5.0 U	5.0 UJ	5.0 U	5.0 U	10 U
Di-n-butyl phthalate	19	5 U	5 UL	5 U	5 UJ	5 U	5 U	5 U	5 UL	5 UL	5 UL	5 UL	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Di-n-octyl phthalate	22	5 U	5 UL	5 U	5 UL	5 U	5 U	5 U	5 UL	5 UL	5 UL	5 UL	5.0 U	5.0 U	5.0 U	5.0 U	10 U
1,4-Dioxane		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2.0 U
Dibenzo (a,h) Anthracene		5 U	5 U	5 UL	5 UJ	5 U	5 UL	5 UL	5 UL	5 UL	5 UL	5 UL	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Diethylphthalate	210	5 U	5 UL	5 U	5 UJ	5 U	5 UL	5 U	5 UL	5 UL	5 UL	5 UL	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Hexachlorocyclopentadiene		5 U	5 U	5 U	5 UJ	5 U	5 UL	5 U	5 U	5 U	5 U	5 UL	5.0 U	5.0 R	5.0 U	5.0 U	10 U
Indeno (1,2,3-cd) Pyrene		5 U	5 U	5 UL	5 UJ	5 U	5 UL	5 UL	5 UL	5 UL	5 UL	5 UL	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
N-Nitrosodiphenylamine	210	5 U	5 U	5 UJ	5 UJ	5 U	5 UL	5 U	5 U	5 U	5 U	5 UL	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Naphthalene	1.1	5 U	5 U	5 U	5 UJ	5 U	5 U	5 U	5 U	5 U	5 U	5 UL	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Pentachlorophenol	0.5	5 U	5 U	5 UJ	5 UJ	5 U	5 U	5 U	5 U	5 U	5 U	5 UL	5.0 U	5.0 U	5.0 U	5.0 U	10 U
Phenol	4	5 U	5 U	5 U	5 UJ	5 U	5 U	5 U	5 U	5 U	5 U	5 UL	5.0 U	5.0 U	5.0 U	5.0 U	10 U
Biological Oxygen Demand (mg/l)		--	--	1.2	2.9	2.1	3.3	3	6	7	--	--	--	--	--	--	--
Field Parameters																	
Temperature (Degrees Celcius)		16.1	--	14.12	21.2	12.3	6.7	16.5	25.9	19.9	6.8	21.7	12.3	16.6	17.6	13.5	22.0
Conductivity (µs/cm)		329	--	335	458	324	133	291	504	343	86	370	653	372	341	460	88
pH (standard units)	6.5 - 9	8.44	--	7.95	5.95	6.84	7.34	7.02	7.26	6.90	7.22	7.37	7.23	6.80	7.12	6.53	7.49
Dissolved Oxygen (mg/l)		4.74	--	8.14	4.50	4.94	9.59	7.22	5.05	5.36	10.51	9.72	3.72	3.97	4.60	2.31	3.61
ORP (mV)		26.2	--	42.2	201	40	159	96	143	8	-11	98	21	106	57	126	125

U - Analyte was not detected above the reporting limit.
J - Estimated concentration.
B - Analyte Detected in Method Blank
-- Not analyzed

D - Sample diluted in the lab for analysis.
K - Analyte present. May be biased High.
L - Analyte present. May be biased low
R - Data Rejected

1/16/2018

Attachment 6 (continued)

Summary of Surface-Water Quality Data for Army Creek and Army Pond

Parameter	BTAG Screening Level µg/l	SWF 10/04	1/05	4/05	7/05	10/05	1/06	4/06	7/06	10/06	1/07	4/07	10/09	10/10	10/11	10/12	10/17
***Dissolved Inorganics* (µg/l)**																	
Aluminum	87	200 U	--	11.9 U	13 U	15.1	53.5 U	49.6 U	19.9 U	20.0 U	36.7 U	11.1 U	200 U	200 U	200 U	200 U	200 U
Antimony	30	2 U	--	3.8 U	3.7 U	1.6 U	1.2 U	1.1 U	1.8 U	1.2 U	1.7 U	2.1 U	60.0 U	60.0 U	60.0 U	60.0 U	60.0 U
Arsenic	5	1.8 U	--	3 U	3.7 U	2 U	1.4 U	1.6 U	2.8 U	2.6 U	2.2 U	2.8 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U
Barium	4	63.7	--	68	53.7	62.3	19.8	39.8	60.1	62.8	36.6	71.3	60.5 J	90.4 J	64.8 J	77.1 J	25.2 J
Beryllium	0.66	0.1 U	--	0.1 U	0.38 U	0.12 U	0.17 U	0.66 U	0.41 J	0.10 U	0.30 U	0.20 U	5.0 U	5.0 U	5.0 U	0.65 J	5.0 U
Cadmium	0.25	0.2 U	--	0.4 U	0.5 U	0.2 U	0.20 U	0.20 U	0.40 U	0.20 U	0.20 U	0.40 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Calcium	116000	21000	--	20400	17600	19200	6720	13100	19300	19900	13000	22000	23700	25000	19000	23400	4710 J
Chromium	85	0.5 U	--	1.2 U	1.3 U	0.6 U	0.58 U	0.60 U	0.50 U	0.55 U	0.66	0.30 U	10.0 U	10.0 U	10.0 U	10.0 U	10 U
Cobalt	23	50 U	--	1.1 U	1.6	0.5 U	0.50 U	0.53	0.71	1.1 U	0.61 U	0.90 U	50.0 U	50.0 U	50.0 U	50.0 U	50.0 U
Copper	9	0.5 U	--	0.9 U	1.4	1.6	2.2	2.6 U	1.5 U	3.8 U	3.2 U	1 U	25.0 U	25.0 U	2.7 J	25 U	25.0 U
Iron (mg/l)	0.3	0.337	1.07	0.621	0.0914 U	0.0841	0.139	0.287	0.0124 U	0.784	0.382	0.021 U	0.100 U	0.154	0.322	0.100 U	0.875 K
Lead	2.5	0.9 U	--	1.2 U	1.6 U	1.1 U	1.0 U	1.0 U	1.9 U	1.6 U	1.2 U	1.8 U	10.0 U	10.0 U	10.0 U	10.0 U	10 U
Magnesium	82000	7950	--	8250	6460 J	7370	2540	4520	7310	8150	5030	8930	10400	9970	8200	9350	6770
Manganese (mg/l)	0.12	0.220	0.283	0.254	0.150	0.0691	0.0369	0.0979	0.129	0.397	0.093	0.209	0.130	0.302	0.178	0.301	0.248
Mercury	0.026	0.2 U	--	0.1 U	0.1 U	0.1 U	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
Nickel	52	0.5 U	--	3.4 U	3.1	3	1.4	2.4	1.5	2.7 U	2.3 U	2.2	40.0 U	40.0 U	40.0 U	1.7 J	5.3 J
Potassium	53000	3580	--	3380 J	4520 J	5800	1980	3450	4510	4370	3070	2880 J	4740 J	3220 J	2760 J	4520 J	1910 J
Selenium	1	3.1	--	4.1 U	4.5 U	4.3 U	3.3 U	1.8 U	2.2 U	2.5 U	2.1 U	2.7 U	35.0 U	35.0 U	35.0 U	3.0 J	35.0 U
Silver	3.2	0.7 U	--	1.4 U	1.3 U	0.2 U	0.50 U	0.50 U	0.30 U	0.59 U	0.40 U	1.2 U	10.0 U	10.0 U	10.0 U	10.0 U	10 U
Sodium	680000	32300	--	53600	46400	23300	9120	20000	31700	26600	13800	53000	56600	46800	31300	42500	1650 J
Thallium	0.8	1.9 U	--	2.9 U	4 U	4.5 U	3.9 U	2.1 U	3.6 U	3.2 U	3.4 U	2.9 U	25.0 U	25.0 U	25.0 U	25.0 U	25.0 U
Vanadium	20	0.4 U	--	1 U	1	0.5 U	0.57	0.77 U	0.30 U	0.61 U	0.79 U	0.50 U	50.0 U	50.0 U	50.0 U	50.0 U	50.0 U
Zinc	120	10.3	--	13.6 U	10.9 UJ	15.2	11.4	13.8	8.9 U	8.6	12.6 U	9	60.0 U	10.9 J	10.2 J	60 U	60.0 U
***Pesticides/Herbicides* (µg/l)**																	
4,4'-DDD		0.02 U	0.02 U	0.02 U	0.02 UJ	0.02 U	0.020 U	--	--	--	--	--	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U
4,4'-DDE		0.02 U	0.02 U	0.02 U	0.0016 J	0.02 U	0.020 U	--	--	--	--	--	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U
4,4'-DDT	0.0005	0.02 U	0.0033 J	0.02 U	0.02 UJ	0.02 U	0.020 U	--	--	--	--	--	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U
Aldrin	3	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.010 U	--	--	--	--	--	0.050 U	0.050 U	0.050 U	0.050 U	0.050 U
alpha-BHC		0.01 U	0.01 U	0.01 U	0.01 UJ	0.011 J	0.010 U	--	--	--	--	--	0.050 U	0.050 U	0.050 U	0.050 U	0.050 U
Alpha-Chlordane		0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.010 U	--	--	--	--	--	0.050 U	0.050 U	0.050 U	0.050 U	0.050 U
beta-BHC		0.01 U	0.01 U	0.01 U	0.0067 J	0.01 U	0.010 U	--	--	--	--	--	0.050 U	0.050 U	0.050 U	0.050 U	0.050 U
delta-BHC	141	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.010 U	--	--	--	--	--	0.050 U	0.050 U	0.050 U	0.050 U	0.050 U
Dieldrin	0.056	0.0076 J	0.011 J	0.0078 J	0.02 UJ	0.0053 J	0.020 U	--	--	--	--	--	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U
Endosulfan I	0.051	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.0023 J	--	--	--	--	--	0.050 U	0.050 U	0.014 J	0.050 U	0.050 U
Endosulfan II	0.051	0.02 U	0.02 U	0.02 U	0.02 UJ	0.02 U	0.020 U	--	--	--	--	--	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U
Endosulfan sulfate		0.02 U	0.02 U	0.02 U	0.02 UJ	0.02 U	0.020 U	--	--	--	--	--	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U
Endrin	0.036	0.02 U	0.02 U	0.02 U	0.02 UJ	0.0077 J	0.020 U	--	--	--	--	--	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U
Endrin Aldehyde		0.02 U	0.02 U	0.02 U	0.02 UJ	0.02 U	0.020 U	--	--	--	--	--	0.10 U	0.10 U	0.10 U	0.10 U	0.011 J
Endrin Ketone		0.02 U	0.02 U	0.02 U	0.02 UJ	0.02 U	0.020 U	--	--	--	--	--	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U
gamma-BHC (Lindane)	0.01	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.010 U	--	--	--	--	--	0.050 U	0.050 U	0.050 U	0.050 U	0.050 U
gamma-Chlordane		0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.010 U	--	--	--	--	--	0.050 U	0.050 U	0.050 U	0.050 U	0.050 U
Heptachlor	0.0019	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.010 U	--	--	--	--	--	0.050 U	0.050 U	0.050 U	0.050 U	0.050 U
Heptachlor Epoxide		0.01 U	0.01 U	0.017	0.01 UJ	0.01 U	0.010 U	--	--	--	--	--	0.050 U	0.050 U	0.050 U	0.050 U	0.050 U
Methoxychlor	0.019	0.1 U	0.1 U	0.1 U	0.1 UJ	0.0047 J	0.10 U	--	--	--	--	--	0.050 U	0.50 U	0.50 U	0.50 U	0.50 U
Toxaphene	0.0002	--	--	--	1 UJ	1 U	1.0 U	--	--	--	--	--	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U

U - Analyte was not detected above the reporting limit.
J - Estimated concentration.
B - Analyte Detected in Method Blank
-- Not analyzed
N - Analysis indicates the presence of an analyte for which there is presumptive evidence to make a "tentative identification"

D - Sample diluted in the lab for analysis.
K - Analyte present. May be biased High.
L - Analyte present. May be biased low
R - Data Rejected
P - Discrepency in GC analysis. Lower value reported.

1/16/2018

Attachment 6 (continued)

Summary of Surface-Water Quality Data for Army Creek and Army Pond

Parameter	BTAG Screening Level	SWG															
	µg/l	10/04	1/05	4/05	7/05	10/05	1/06	4/06	7/06	10/06	1/07	4/07	10/09	10/10	10/11	10/12	10/17
Non-Halogenated VOCs **(µg/l)**																	
Benzene	370	0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
Toluene	2	0.5 U	5 U	5 U	5 U	5 UJ	10 U	0.19 J	1 U	1 U	1 U	1 U	--	--	--	--	--
Ethylbenzene	90	0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
Xylene (total)	13	0.5 U	5 U	5 U	5 U	5 U	10 U	3 U	3 U	3 U	3 U	3 U	--	--	--	--	--
2-Butanone	14000	5 U	10 U	10 R	10 R	10 UJ	10 U	5 U	5 U	5 U	5 U	5 U	--	--	--	--	--
Acetone	1500	5 U	20 R	20 R	20 R	20 R	10 U	5 UJ	11 U	5 U	5 UJ	5 U	--	--	--	--	--
Carbon Disulfide	0.92	0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
Cyclohexane		0.5 U	--	--	--	--	10 U	1 U	1 U	1 U	1 U	1 UJ	--	--	--	--	--
Isopropylbenzene	2.6	0.5 U	--	--	--	--	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
Methy-tert-butyl ether	11070	0.5 K	--	--	--	--	1.1 J	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
Methylcyclohexane		0.5 U	--	--	--	--	10 U	1 U	1 U	1 U	1 U	1 UJ	--	--	--	--	--
4-Methy-2-pentanone	170	5 U	10 U	10 U	10 U	10 UJ	10 U	5 U	5 U	5 U	5 U	5 U	--	--	--	--	--
Halogenated VOCs **(µg/l)**																	
Bromoform	320	0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 U	1 U	1 U	1 U	1 UJ	--	--	--	--	--
Bromodichloromethane		0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
Carbon Tetrachloride	13.3	0.5 U	5 UJ	5 U	5 U	5 UJ	10 UJ	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
Chlorobenzene	1.3	0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
Chloroform	1.8	0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
Dibromochloromethane		0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
1,2-Dichloroethane	100	0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
1,1-Dichloroethane	47	0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
cis-1,2-Dichloroethene		0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
trans-1,2-Dichloroethene	970	0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
1,1-Dichloroethene	25	0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
1,2-Dichlorobenzene	0.7	0.5 U	--	--	--	--	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
1,3-Dichlorobenzene	150	0.5 U	--	--	--	--	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
1,4-Dichlorobenzene	26	0.5 U	--	--	--	--	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
Chloroethane		0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 R	1 U	1 U	1 U	1 U	--	--	--	--	--
Tetrachloroethene	111	0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
1,1,1-Trichloroethane	11	0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
Trichloroethene	21	0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
Vinyl Chloride	930	0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
1,2,4-Trichlorobenzene	24	0.5 U	--	--	--	--	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
cis-1,3-Dichloropropene		0.5 U	5 U	5 U	5 U	5 UJ	10 U	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
Methylene Chloride	98.1	0.27 K	5 U	5 U	5 U	5 UJ	10 U	1 U	1 UJ	1 UJ	1 UJ	1 UJ	--	--	--	--	--
Trichlorofluoromethane		0.5 U	--	--	--	--	10 U	1 UJ	1 U	1 U	1 U	1 U	--	--	--	--	--
Semi-Volatiles **(µg/l)**																	
1,1'-Biphenyl	14	5 U	5 U	5 U	5 UL	5 U	5 U	5 U	5 U	5 UL	5 U	5 UL	5.1 U	5.0 U	5.0 U	5.0 U	5.0 U
2,2'-oxybis (1-Chloropropane)		5 U	5 U	5 U	5 UJ	5 U	5 UL	5 U	5 U	5 UL	5 U	5 UL	5.1 U	5.0 U	5.0 U	5.0 U	--
2,4-Dimethylphenol		5 U	5 U	5 U	5 UJ	5 U	5 U	5 U	5 U	5 UL	5 U	5 UL	5.1 U	5.0 U	5.0 U	5.0 U	5.0 U
2,4-Dinitrophenol		20 U	20 U	20 UJ	20 UL	20 U	20 UL	20 U	20 UL	20 UL	20 U	20 UL	10 U	10 U	10 U	10 U	10 U
2,6-Dinitrotoluene	81	5 UJ	5 U	5 U	5 UJ	5 U	5 U	5 U	5 U	5 U	5 U	5 UL	5.1 U	5.0 U	5.0 U	5.0 U	5.0 U
2-Methylnaphthalene	4.7	5 U	5 U	5 U	5 UJ	5 U	5 U	5 U	5 UL	5 UL	5 U	5 UL	5.1 U	5.0 U	5.0 U	5.0 U	5.0 U
2-Methylphenol	13	5 U	5 U	5 U	5 UJ	5 U	5 U	5 U	5 U	5 UL	5 U	5 UL	5.1 U	5.0 U	5.0 U	5.0 U	10 U
4,6-Dinitro-2-methylphenol		20 U	20 U	20 U	20 UJ	20 U	20 UL	20 U	20 U	20 U	20 U	20 UL	10 U	10 U	10 U	10 U	10 U
4-Methylphenol	543	5 U	5 U	5 U	5 UJ	5 U	5 U	5 U	5 U	5 UL	5 U	5 UL	5.1 U	5.0 U	5.0 U	5.0 U	10 U
Acetophenone		5 U	5 U	5 U	5 UJ	5 U	5 U	5 U	5 U	5 U	5 U	5 UL	5.1 U	5.0 U	5.0 U	5.0 U	10 U
Atrazine	1.8	5 UJ	5 U	5 U	5 UL	5 U	5 UL	5 UL	5 U	5 UL	5 U	5 UL	5.1 UJ	5.0 U	5.0 U	5.0 U	10 U
Benzaldehyde		5 UJ	5 U	5 UL	5 UL	5 U	5 U	5 UL	5 U	5 U	5 U	5 UL	5.1 UJ	5.0 UJ	5.0 U	5.0 U	10 U
Benzo (a) pyrene	0.015	5 U	5 U	5 U	5 UL	5 U	5 UL	5 UL	5 UL	5 UL	5 UL	5 UL	5.1 U	5.0 U	5.0 U	5.0 U	5.0 U
Benzo (b) Fluoranthene		5 U	5 U	5 U	5 UL	5 U	5 UL	5 UL	5 UL	5 UL	5 UL	5 UL	5.1 U	5.0 U	5.0 U	5.0 U	5.0 U
Benzo (g,h,i) Perylene		5 U	5 U	5 U	5 UL	5 U	5 UL	5 UL	5 UL	5 UL	5 UL	5 UL	5.1 U	5.0 U	5.0 U	5.0 U	5.0 U
Benzo (k) Fluoranthene		5 UJ	5 U	5 U	5 UL	5 U	5 UL	5 UL	5 UL	5 UL	5 UL	5 UL	5.1 U	5.0 U	5.0 U	5.0 U	5.0 U
Bis(2-chloroethyl)Ether		0.019 U	0.021	0.041	0.02 UJ	0.019 UL	5 U	5 U	5 U	5 UL	5 U	5 UL	5.1 U	5.0 U	5.0 U	5.0 U	10 U
Bis(2-ethylhexyl)phthalate	16	5 U	5 U	5 U	5 UL	5 U	5 U	5 UL	5 UL	5 UL	5 U	5 UL	5.1 U	5.0 U	5.0 U	5.0 U	5.0 U
Caprolactam		5 UJ	5 U	5 U	5 UL	5 U	5 UL	5 UL	5 UL	5 UL	5 U	5 UL	5.1 U	5.0 U	5.0 U	5.0 U	10 U
Di-n-butyl phthalate	19	5 U	5 U	5 U	5 UL	5 U	5 U	5 U	5 UL	5 UL	5 U	5 UL	5.1 U	5.0 U	5.0 U	5.0 U	5.0 U
Di-n-octyl phthalate	22	5 U	5 U	5 U	5 UL	5 U	5 U	5 U	5 UL	5 UL	5 U	5 UL	5.1 U	5.0 U	5.0 U	5.0 U	10 U
1,4-Dioxane		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2.0 U
Dibenzo (a,h) Anthracene		5 U	5 U	5 U	5 UL	5 U	5 UL	5 UL	5 UL	5 UL	5 UL	5 UL	5.1 U	5.0 U	5.0 U	5.0 U	5.0 U
Diethylphthalate	210	5 U	5 U	5 U	5 UL	5 U	5 UL	5 U	5 UL	5 UL	5 U	5 UL	5.1 U	5.0 U	5.0 U	5.0 U	5.0 U
Hexachlorocyclopentadiene		5 U	5 U	5 U	5 UJ	5 U	5 UL	5 U	5 U	5 U	5 U	5 UL	5.1 U	5.0 R	5.0 U	5.0 U	10 U
Indeno (1,2,3-cd) Pyrene		5 U	5 U	5 U	5 UJ	5 U	5 UL	5 UL	5 UL	5 UL	5 UL	5 UL	5.1 U	5.0 U	5.0 U	5.0 U	5.0 U
N-Nitrosodiphenylamine	210	5 U	5 U	5 UJ	5 UJ	5 U	5 UL	5 U	5 U	5 U	5 U	5 UL	5.1 U	5.0 U	5.0 U	5.0 U	5.0 U
Naphthalene	1.1	5 U	5 U	5 U	5 UJ	5 U	5 U	5 U	5 UL	5 UL	5 U	5 UL	5.1 U	5.0 U	5.0 U	5.0 U	5.0 U
Pentachlorophenol	0.5	5 U	5 U	5 UJ	5 UL	5 U	5 U	5 U	5 U	5 UL	5 U	5 UL	5.1 U	5.0 U	5.0 U	5.0 U	10 U
Phenol	4	5 U	5 U	5 U	5 UJ	5 U	5 U	5 U	5 U	5 U	5 U	5 UL	5.1 U	5.0 U	5.0 U	5.0 U	10 U
Biological Oxygen Demand (mg/l)		--	--	1.8	4.4	2.4	3.9	3	10	5	--	--	--	--	--	--	--
Field Parameters																	
Temperature (Degrees Celcius)		16.2	--	11.7	23.01	12.3	7.1	19.2	29.6	19.0	6.3	20.4	11.9	16.6	18.2	13.0	21.0
Conductivity (µs/cm)		338	--	291	299	294	105	273	270	278	107	334	554	296	444	323	143
pH (standard units)	6.5 - 9	8.25	--	5.89	6.40	6.76	7.40	7.08	6.93	6.94	6.62	7.66	7.23	6.83	6.80	6.41	7.34
Dissolved Oxygen (mg/l)		5.38	--	7.55	1.78	3.83	9.93	7.45	7.44	7.03	9.36	10.55	3.24	3.18	5.89	9.58	4.75
ORP (mV)		-7.3	--	51	76.9	-24	160	82	55	37	42	77	48	53	67	39	141

U - Analyte was not detected above the reporting limit.
J - Estimated concentration.
B - Analyte Detected in Method Blank
-- Not analyzed.
UL - Not detected, quantitation limit is probably higher

D - Sample diluted in the lab for analysis.
K - Analyte present. May be biased High.
L - Analyte present. May be biased low
R - Data Rejected

1/16/2018

Attachment 6 (continued)

Summary of Surface-Water Quality Data for Army Creek and Army Pond

Parameter	BTAG Screening Level µg/l	SWG 10/04	1/05	4/05	7/05	10/05	1/06	4/06	7/06	10/06	1/07	4/07	10/09	10/10	10/11	10/12	10/17
***Dissolved Inorganics* (µg/l)**																	
Aluminum	87	4.4 U	--	11.9 U	18.7 UJ	27.1 U	83.7 U	50.5 U	37.6 U	20.0 U	43.0 U	11.1 U	200 U	200 U	200 U	200 U	200 U
Antimony	30	2 U	--	3.8 U	3.7 UJ	1.6 U	1.2 U	1.1 U	1.8 U	1.2 U	1.7 U	2.1 U	60.0 U	60.0 U	60.0 U	60.0 U	60.0 U
Arsenic	5	1.8 U	--	3 U	3.7 UJ	2 U	2.4	1.6 U	2.8 U	2.6 U	2.2 U	2.8 U	10.0 U	10.0 U	10.0 U	10.0 U	10 U
Barium	4	52.6	--	51.1	59.4 J	70.5	17.9	48.3	47.3	55.1	30.6	67.5	46.3 J	66.7 J	62.7 J	52.3 J	36.4 J
Beryllium	0.66	0.1 U	--	0.1 U	0.59 UJ	0.2 U	0.38 U	0.65 U	0.62 U	0.10 U	0.30 U	0.20 U	5.0 U	5.0 U	5.0 U	0.76 J	5.0 U
Cadmium	0.25	0.2 U	--	0.4 U	0.5 UJ	0.2 U	0.23 U	0.20 U	0.40 U	0.20 U	0.20 U	0.40 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Calcium	116000	18600	--	17200	20100 J	18000	6150	13500	17800	19000	11100	22300	22700	21800	31800	19500	10300
Chromium	85	0.5 U	--	1.6 U	1.1 UJ	0.6 U	0.72 U	0.60 U	0.50 U	0.77 U	0.60 U	0.30 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U
Cobalt	23	50 U	--	1.1 U	1.1 UJ	0.75	0.50 U	0.40	2.4	0.65 U	0.40 U	0.90 U	50.0 U	50.0 U	50.0 U	50.0 U	50.0 U
Copper	9	0.5 U	--	0.99	0.83 J	1.2	2.4	2.2 U	1.7	3.4 U	3.3 U	1.2 U	25.0 U	25.0 U	1.3 J	25 U	25 U
Iron (mg/l)	0.3	0.011 U	0.713	0.207 U	0.571 J	1.29	0.159	0.390	0.112	0.0663 U	0.295	0.108 U	0.100 U	0.148	0.124	0.0877 J	0.204 K
Lead	2.5	0.9 U	--	1.2 U	1.6 UJ	1.1 U	1.0 U	1.0 U	1.9 U	1.6 U	1.2 U	1.5 U	10.0 U	10.0 U	10.0 U	10.0 U	10 U
Magnesium	82000	7060	--	6240	8780 J	7410	2090	5070	6760	7090	3950	8610	9900	7630	9530	6850	3440 J
Manganese (mg/l)	0.12	0.173	0.339	0.263	0.190 J	0.322	0.0404	0.188	0.126	0.163	0.0787	0.164	0.0865	0.116	0.220	0.149	0.0833
Mercury	0.026	0.2 U	--	0.1 U	0.1 UJ	0.1 U	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
Nickel	52	0.5 U	--	3.6 U	2.9 J	2.6	1.5	2.0	1.4	1.9 U	2.2 U	2.5	40.0 U	2.1 J	40.0 U	1.6 J	1.5 J
Potassium	53000	3560	--	3140 J	3580 J	4270	1810	3520	4390	4160	2910	2420 J	4790 J	3090 J	2730 J	3510 J	6050
Selenium	1	2.6 U	--	1.7 U	4.5 J	4.3 U	3.3 U	1.8 U	2.2 U	2.5 U	2.1 U	2.7 U	35.0 U	35.0 U	35.0 U	35.0 U	35.0 U
Silver	3.2	0.7 U	--	1.4 U	1.3 UJ	0.2 U	0.50 U	0.50 U	0.30 U	0.53 U	0.40 U	1.2 U	10.0 U	10.0 U	10 U	10.0 U	10 U
Sodium	680000	24100	--	26900	26800 J	18700	6130	17300	17700	17900	11300	43300	36000	32400	32200	30900	11700
Thallium	0.8	1.9 U	--	2.9 U	4 UJ	4.5 U	3.9 U	2.1 U	3.6 U	3.3 U	3.4 U	2.9 U	25.0 U	25.0 U	25.0 U	25.0 U	25.0 U
Vanadium	20	0.4 U	--	1 U	0.96 J	0.5 U	0.85	0.59 U	0.78	0.40 U	0.67 U	0.50 U	50.0 U	50.0 U	50.0 U	50.0 U	50.0 U
Zinc	120	8.7	--	10.7 U	5.3 UJ	13.1	11	6.1	7.7 U	6.2	10.7 U	8.8	60.0 U	12.1 J	7.9 J	60 U	10 J
***Pesticides/Herbicides* (µg/l)**																	
4,4'-DDD		0.02 U	0.02 U	0.02 U	0.02 UJ	0.02 U	0.020 U	--	--	--	--	--	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U
4,4'-DDE		0.02 U	0.02 U	0.02 U	0.0039 J	0.0077 J	0.020 U	--	--	--	--	--	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U
4,4'-DDT	0.0005	0.02 U	0.02 U	0.02 U	0.02 UJ	0.02 U	0.020 U	--	--	--	--	--	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U
Aldrin	3	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.010 U	--	--	--	--	--	0.050 U	0.050 U	0.050 U	0.050 U	0.050 U
alpha-BHC		0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.010 U	--	--	--	--	--	0.050 U	0.050 U	0.050 U	0.050 U	0.050 U
Alpha-Chlordane		0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.010 U	--	--	--	--	--	0.050 U	0.050 U	0.050 U	0.050 U	0.050 U
beta-BHC		0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.010 U	--	--	--	--	--	0.050 U	0.050 U	0.050 U	0.050 U	0.050 U
delta-BHC	141	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.010 U	--	--	--	--	--	0.050 U	0.050 U	0.050 U	0.050 U	0.050 U
Dieldrin	0.056	0.02 U	0.0083 J	0.02 U	0.0071 JN	0.02 U	0.020 U	--	--	--	--	--	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U
Endosulfan I	0.051	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.0035 J	--	--	--	--	--	0.050 U	0.050 U	0.050 U	0.017 J	0.050 U
Endosulfan II	0.051	0.02 U	0.02 U	0.02 U	0.02 UJ	0.02 U	0.020 U	--	--	--	--	--	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U
Endosulfan sulfate		0.02 U	0.02 U	0.02 U	0.02 UJ	0.02 U	0.020 U	--	--	--	--	--	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U
Endrin	0.036	0.02 U	0.02 U	0.02 U	0.02 UJ	0.02 U	0.020 U	--	--	--	--	--	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U
Endrin Aldehyde		0.02 U	0.02 U	0.02 U	0.02 UJ	0.02 U	0.020 U	--	--	--	--	--	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U
Endrin Ketone		0.02 U	0.02 U	0.02 U	0.02 UJ	0.02 U	0.020 U	--	--	--	--	--	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U
gamma-BHC (Lindane)	0.01	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.010 U	--	--	--	--	--	0.050 U	0.050 U	0.050 U	0.050 U	0.050 U
gamma-Chlordane		0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.010 U	--	--	--	--	--	0.050 U	0.050 U	0.050 U	0.050 U	0.0037 J
Heptachlor	0.0019	0.01 U	0.01 U	0.01 U	0.01 UJ	0.01 U	0.010 U	--	--	--	--	--	0.050 U	0.050 U	0.050 U	0.050 U	0.050 U
Heptachlor Epoxide		0.01 U	0.01 U	0.025 J	0.01 UJ	0.01 U	0.010 U	--	--	--	--	--	0.050 U	0.050 U	0.050 U	0.050 U	0.022 K
Methoxychlor	0.019	0.1 U	0.1 U	0.1 U	0.1 UJ	0.1 U	0.10 U	--	--	--	--	--	0.050 U	0.50 U	0.50 U	0.50 U	0.50 U
Toxaphene	0.0002	--	--	--	1 UJ	1 U	1.0 U	--	--	--	--	--	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U

N - Analysis indicates the presence of an analyte for which there is presumptive evidence to make a "tentative identification"

U - Analyte was not detected above the reporting limit.

J - Estimated concentration.

B - Analyte Detected in Method Blank

-- Not analyzed

D - Sample diluted in the lab for analysis.

K - Analyte present. May be biased High.

L - Analyte present. May be biased low

R - Data Rejected

P - Discrepency in GC analysis. Lower value reported.

1/16/2018