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Rolling Knolls Landfill Settling Parties

Quality Assurance Project Plan for the Data Gaps Sampling and Analysis Plan

Rolling Knolls Landfill Superfund Site

Chatham, New Jersey

September 2014

Quality Assurance Project Plan for the Data Gaps Sampling and Analysis Plan

Rolling Knolls Landfill Superfund Site
Chatham, New Jersey

Prepared for:
Rolling Knolls Landfill Settling Parties

Prepared by:
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Date:
September 2014

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2014 Quality Assurance Project Plan (QAPP) Worksheets

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QAPP Worksheet #1 & 2: Title and Approval Page

1. **Project Identifying Information**

    a. **Site name/project name**: Rolling Knolls Landfill Superfund Site

    b. **Site location/number**: The site is located at the southern end of Britten Road south of Green Village in Chatham Township, Morris County, New Jersey

    c. **Contract/Work assignment number**: Index No. II-CERCLA-02-2005-2034

2. **Federal Regulatory Agency**: Tanya Mitchell, Remedial Project Manager, United States Environmental Protection Agency (USEPA) Region

    _____ (Signature/Date)

3. **State Regulatory Agency**: Gwen Zervas, Case Manager, New Jersey Department of Environmental Protection (NJDEP)

    _____ (Signature/Date)

4. **Lead Organization**: ARCADIS US, Inc.

    a. **Lead Organization Project Coordinator**: John Persico, Designated Project Coordinator, ARCADIS

    _____ (Signature/Date)

    b. **Lead Organization Project Manager**: Suzanne J. Walls, Project Manager, ARCADIS

    _____ (Signature/Date)

    c. **Lead Organization Quality Manager**: Dennis K. Capria, Quality Assurance Manager, ARCADIS

    _____ (Signature/Date)

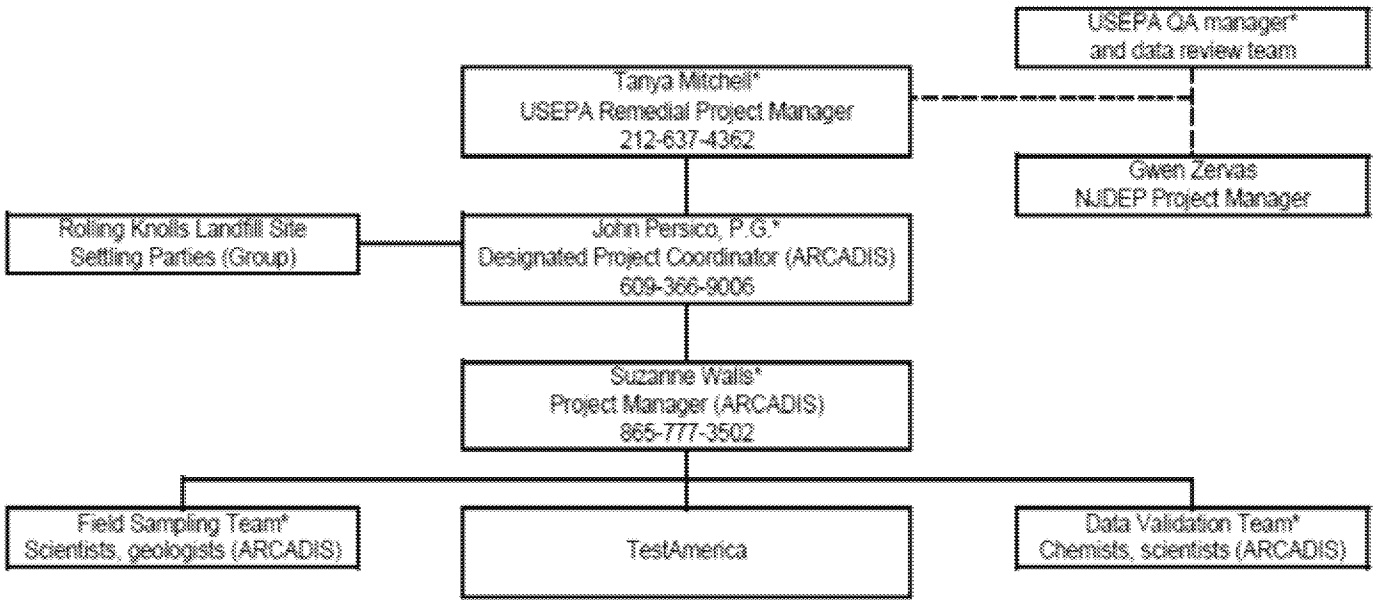
5. **Other Stakeholders**: United States Fish and Wildlife Service (USFWS), Robert J. Miele as Trustee for the Trust created by the Last Will and Testament of Angelo J. Miele and the Green Village Fire Department

6. **Plans and reports from previous investigations relevant to this project**:

    Site Characterization Summary Report (ARCADIS US Inc., February 2012) and the Baseline Human Health Risk Assessment (CDM, June 2014)

QAPP Worksheet #3 & 5: Project Organization and QAPP Distribution

*QAPP recipient Lines of authority _____ Lines of Communication ----------



* - QAPP recipient

QAPP Worksheet #4, 7 & 8: Personnel Qualifications and Sign-off Sheet

Name	Project Title/Role	Education/Experience	Specialized Training/Certifications	Signature/Date
John Persico	Designated Project Coordinator (ARCADIS)	B.A. Geology, M.S. Geology/Geochemistry, 26 years of experience RIFS	P.G.	
Suzanne Walls	Project Manager (ARCADIS)	B.S. Biology, Environmental Politics, M.S. Entomology (in progress), 9 years of ecological risk experience	Certified Ecologist	
Dennis Capria	Quality Assurance (QA) Manager (ARCADIS)	B.S. Biology, minor Chemistry; 26 years of experience		
Kathryn Kelly	Project Manager (TestAmerica)	B.A. English		
Sara Goff	Laboratory QA Manager (TestAmerica)	B.S. Health Sciences		

*Signatures indicate personnel have read and agree to implement this QAPP as written

QAPP Worksheet #6: Communication Pathways

Communication Driver	Organization	Name	Contact Information	Procedure (timing, pathway, documentation, etc.)
Regulatory agency interface	USEPA	Tanya Mitchell	212.637.4362	To be contacted as needed.
Field progress reports	ARCADIS	Suzanne Walls, Project Manager	865.777.3502	To be provided daily field progress reports (through email or phone calls). Will provide complete sets of daily field progress reports, sampling logs, chains-of-custody forms, and other information to the Remedial Investigation (RI) Field Program Coordinator.
Coordinate Field Program	ARCADIS	Suzanne Walls, Project Manager	865.777.3502	To be notified of field related questions or problems by phone or email.
Stop work due to safety issues	ARCADIS	Any employee		Any employees who feel the workplace is unsafe can stop work until the safety issue is resolved.
QAPP changes prior to field work and during project executions	ARCADIS	Dennis Capria, QA Manager	315.671.9299	Any major changes to the QAPP must be approved by Dennis Capria and the Project Coordinator and USEPA before the changes can be implemented.
Unfulfilled or changes to bottle orders	TestAmerica	Kathryn Kelly, Project Manager	802.923.1021	To be notified of any problems or changes related to bottle orders.
Field equipment	Pine Environmental Services	Pine Environmental Services Staff	800.301.9663	To be notified of any problems or changes to field equipment rentals.
Sample receipt or chain of custody variances	ARCADIS	Suzanne Walls, Project Manager	865.777.3502	To be notified of any sample receipt or chain of custody variances.

Communication Driver	Organization	Name	Contact Information	Procedure (timing, pathway, documentation, etc.)
Laboratory quality control variances	ARCADIS	Dennis Capria, QA Manager	315.671.9299	To be notified of any laboratory control variances.
Analytical corrective actions	ARCADIS	Dennis Capria, QA Manager	315.671.9299	The need for corrective action for analytical issues will be determined by Dennis Capria in conjunction with the Project Coordinator, the Field Program Coordinator or the Laboratory QA Manager, as appropriate.
Field corrective actions	ARCADIS	Suzanne Walls, Project Manager	865.777.3502	The need for corrective action for field issues will be determined by Suzanne Walls with the Project Coordinator, the Field Program Coordinator or the Laboratory QA Manager, as appropriate.
Reporting Lab Data Quality Issues	TestAmerica	Kathryn Kelly, Project Manager	802.923.1021	All QA/QC issues with project field samples will be reported by contact person from TestAmerica to Suzanne Walls and Dennis Capria within 2 business days.
Data validation issues, e.g., non-compliance with procedures	TestAmerica	Kathryn Kelly, Project Manager	802.923.1021	All data validation concerns will be reported to Dennis Capria and TestAmerica.
Data review corrective actions	ARCADIS	Dennis Capria, QA Manager	315.671.9299	The need for corrective action during data review will be determined by John Persico in conjunction with Suzanne Walls.

QAPP Worksheet #9: Project Planning Session Summary

Date of planning session: August 13, 2014
Location: Fair Lawn, NJ and conference call
Purpose: Discuss progress on the Data Gaps Sampling and Analysis Plan and QAPP
Participants:

Name	Organization	Title/Role	Email/Phone
John Persico	ARCADIS	Designated Project Coordinator	John.Persico@arcadis-us.com
Suzanne Walls	ARCADIS	Project Manager	Suzy.Walls@arcadis-us.com
Dana Drew	ARCADIS	Geologist	Dana.Drew@arcadis-us.com

Notes/Comments:

- Discussion of the USEPA comments on the Baseline Ecological Risk Assessment (BERA) Work Plan and Data Gaps Memo.
- Discussion of the revised sampling locations and analyses in the Data Gaps Memo and BERA Work Plan.
- Discussion of the Baseline Human Health Risk Assessment (BHHRA) results from CDM Smith (CDM).

Date of planning session: August 14, 2014
Location: Conference call
Purpose: Discuss USEPA comments on the Data Gaps Memo
Participants:

Name	Organization	Title/Role	Email/Phone
John Persico	ARCADIS	Designated Project Coordinator	John.Persico@arcadis-us.com
Suzanne Walls	ARCADIS	Project Manager	Suzy.Walls@arcadis-us.com
Andrew Gutherz	ARCADIS	Task Manager	Andrew.Gutherz@arcadis-us.com
Dana Drew	ARCADIS	Geologist	Dana.Drew@arcadis-us.com

Notes/Comments:

- Discussion of the Data Gaps Sampling and Analysis Plan.
- Review of additional sampling locations and analyses requested by the USEPA.
- Discussion of well X-7, which was previously not sampled due to the lack of water and recharge during sampling.
- Discussion of the pattern of the previously proposed temporary well locations.

Date of planning session: August 14, 2014
Location: Conference call
Purpose: Discuss USEPA comments on the Data Gaps Memo
Participants:

Name	Organization	Title/Role	Email/Phone
John Persico	ARCADIS	Designated Project Coordinator	John.Persico@arcadis-us.com
Suzanne Walls	ARCADIS	Project Manager	Suzy.Walls@arcadis-us.com
Andrew Gutherz	ARCADIS	Task Manager	Andrew.Gutherz@arcadis-us.com
Dana Drew	ARCADIS	Geologist	Dana.Drew@arcadis-us.com
Gary Fisher	Alcatel-Lucent	Remedial Project Manager	gary.fisher@alcatel-lucent.com
Michael Draikiwicz	Novartis	Remediation Project Manager	michael.draikiwicz@novartis.com
Richard Hughes	Jackson Walker LLP	Counsel to Chevron	rhughes@jw.com
Rich Ricci	Lowenstein Sandler LLP	Counsel to Group	rricci@lowenstein.com
Mark Stella	Chevron	Remediation Project Manager	MarkStella@Chevron.com
Mickey Faigen	Issues Management LLC	Consultant to Group	Mfaigen@issuesllc.com

Notes/Comments:

- Discussion of the USEPA comments on the Data Gaps Memo and proposed responses.

Date of planning session: August 19, 2014
Location: 290 Broadway New York, NY and conference call
Purpose: Discuss comments on the Data Gaps Memo with USEPA
Participants:

Name	Organization	Title/Role	Email/Phone
John Persico	ARCADIS	Designated Project Coordinator	John.Persico@arcadis-us.com
Andrew Gutherz	ARCADIS	Task Manager	Andrew.Gutherz@arcadis-us.com
Tanya Mitchell	USEPA	Remedial Project	Mitchell.Tanya@epa.gov

Name	Organization	Title/Role	Email/Phone
		Manager	
Michael Sivak	USEPA	Chief, Mega Projects Section	Sivak.Michael@epa.gov
Michael Clemetson	USEPA	Ecological Risk Assessor	Clemetson.Michael@epa.gov
Katherine Mishkin	USEPA	Geologist	Mishkin.Katherine@epa.gov
Juan Fajardo	USEPA	Counsel at USEPA	Fajardo.Juan@epa.gov
George Molnar	CDM Smith	Consultant to USEPA	MolnarGC@cdmsmith.com
John Dougherty	CDM Smith	Consultant to USEPA	DoughertyJ@cdmsmith.com
Mark Stella	Chevron	Remediation Project Manager	MarkStella@Chevron.com
Gary Fisher	Alcatel-Lucent	Remediation Project Manager	gary.fisher@alcatel-lucent.com
Michael Draikiwicz	Novartis	Remediation Project Manager	michael.draikiwicz@novartis.com
Mickey Faigen	Issues Management LLC	Consultant	mfaigen@issuesllc.com
Rich Ricci	Lowenstein Sandler LLP	Counsel to Group	rricci@lowenstein.com

Notes/Comments:

- Discussion of the EPA comments on the Data Gaps Memo.
- Consensus decisions made on sampling locations and analyses for the Data Gaps Sampling and Analysis Plan.
- Action Items:

Action	Responsible Party	Due Date
ARCADIS will prepare the Data Gaps Sampling and Analysis Plan and Quality Assurance Project Plan and send to USEPA for approval.	ARCADIS	Week of September 15, 2014
USEPA will review Data Gaps Sampling and Analysis Plan within 3 weeks and 2 days after receipt, and the Quality Assurance Project Plan within 3 weeks after receipt.	USEPA	October 2014

QAPP Worksheet #10: Conceptual Site Model

Background Information

1. Site Description

The Rolling Knolls Landfill Superfund Site consists of a former privately operated municipal waste landfill located at the southern end of Britten Road, south of Green Village in Chatham Township, Morris County, New Jersey (Figure 1). The landfill covers 141 acres and consists of a relatively thin (18 feet or less) layer of waste material directly overlying native soil and/or wetlands. An area of surface debris was identified on 29 acres west of the landfill. The central and western portions of the landfill are owned by Robert J. Miele as Trustee of the Trust created by the Last Will and Testament of Angelo J. Miele, the former landfill operator. Eastern and southern portions are located within the Great Swamp National Wildlife Refuge (GSNWR) and owned by the United States Fish & Wildlife Service (USFWS). A northeastern portion of the landfill occurs on a parcel owned by the Green Village Fire Department.

2. Site History

The former privately operated municipal waste landfill located at the southern end of Britten Road reportedly operated from the 1930s to 1968. During this period, materials disposed at the landfill consisted primarily of municipal solid waste, but also included other waste such as industrial waste.

During the RI, an extensive characterization was implemented to evaluate the extent and composition of the landfill and potential landfill-related impacts to environmental media (Site Characterization Summary Report, February 2012). The RI efforts consisted of test pits, drum investigations, surface and subsurface soil collection, soil borings, monitoring well installations, sub slab vapor intrusion sampling, and surface water and sediment sampling.

Nature and Extent of Constituents

1. Constituent Sources

Sources of constituents detected in environmental media during RI activities can be considered as point sources and non-point sources. The largest potential source is the landfill itself. It is broad (141 acres) and relatively thin (18 feet or less) and directly overlies native soil. Because it consists almost entirely of municipal solid waste, the landfill is a diffuse source of organic and inorganic constituents. Limited areas of various waste materials that likely serve as individual point sources have been observed, but are a minor component of the total waste volume. Other potential sources of constituents are precipitation (e.g., mercury), natural background concentrations in soil and groundwater (i.e., inorganics), and/or current human activities such as hunting, skeet shooting, activities at the landscaping areas (e.g., vehicle/equipment storage and maintenance, storage of mulch, rocks and other landscaping supplies, storage of fertilizers and/or pesticides), activities during landfill operations, or uncontrolled disposal by trespassers. Based on the conditions within the landfill boundary, historical information regarding landfill disposal and maintenance activities, and the nature and extent of constituents in environmental media, it is probable that only a small amount of industrial waste has been disposed of at the landfill.

2. Constituent Detections in Soil and Groundwater

a. Soil

Surface soil samples were collected from known human use areas, both on and adjacent to the landfill, (baseball field, shooting range, landscape areas and near the Hunt Club building) as well as throughout the landfill. These samples exhibited detections of volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), polychlorinated biphenyls (PCBs), pesticides, dioxins, furans, and/or inorganic constituents. The most commonly detected constituents in surface soil were polycyclic aromatic hydrocarbons (PAHs), phthalates, PCBs, pesticides and inorganic constituents. Concentrations of some of these constituents exceed New Jersey Residential and/or Nonresidential Soil Remediation Standards (SRSs) and ecologically based screening levels (EBSLs).

Fewer exceedances of the Residential and Nonresidential SRSs are noted in the human use areas, in particular the baseball field, shooting range, and Landscape Area 2 and Hunt Club building. The baseball field and shooting range are located north of the landfill. Test pits excavated in this area did not identify waste at the ground surface or at depth and analytical results do not suggest that soil in this area has been impacted by the landfill. Landscape Area 2 and the Hunt Club building occur within the surface debris area located in the western portion of the landfill. Exceedances of SRSs from surface soil in these three areas were limited to certain PAHs and vanadium (at one location in the shooting range). Landscape Area 1 occurs near the center of the landfill and directly abuts landfilled materials. Higher exceedances of Residential and Nonresidential SRSs in these samples, relative to the other human use areas, identify potential impacts from the landfill and/or the ongoing activities at the landscaping area (e.g., maintenance and storage of equipment and vehicles).

Surface soil samples collected across the entire landfill (inclusive of the landscaping and Hunt Club areas) exhibit exceedances of Residential and/or Nonresidential SRSs for PAHs, phthalates, PCBs, certain pesticides and inorganic constituents. Few VOCs were detected at concentrations greater than SRSs, and exceedances were limited to isolated locations. Few exceedances are noted in the surface debris area in the western portion of the landfill and along the western and southwestern perimeter of the landfill.

Subsurface soil samples collected within the potentially developable portion of the landfill exhibited detections of VOCs, SVOCs, PCBs, pesticides and/or inorganic constituents. The most commonly detected constituents in subsurface soil were PAHs, phthalates, PCBs, pesticides and inorganic constituents. Concentrations of some of these constituents exceed Residential and/or Nonresidential SRSs, including certain PAHs, bis(2-ethylhexyl) phthalate, PCBs, pesticides and inorganic constituents.

b. Groundwater

Sources of contamination to groundwater, within the landfill, include groundwater infiltration through the impacted waste materials and soil, as well as some potential sources upgradient of the landfill, particularly inorganic constituents.

Groundwater sampling results indicate that a variety of constituents were detected in groundwater. In general, detections of organic constituents in samples collected from groundwater monitoring wells during both the December 2007 and February 2008 sampling events were limited to a subset of VOCs, SVOCs and pesticides. Inorganic constituents were ubiquitously detected in groundwater samples. PCBs were not detected in groundwater samples collected during either sampling event. Detected VOCs included chlorinated solvents (e.g., cis-1,2-dichloroethene [cis-1,2-DCE], trichloroethylene [TCE] and tetrachloroethylene [PCE]), benzene, toluene, ethylbenzene, and xylene (BTEX) compounds and chlorofluorocarbons (CFCs), among others. Exceedances of New Jersey (NJ) Groundwater Quality Criteria (GWQC) were limited to a small subset of these organic and inorganic constituents and occurred most frequently in three monitoring wells: MW-3, MW-7 and MW-10.

Exceedances of NJ GWQC at MW-7 were limited to iron and manganese in December 2008 and aluminum, iron, lead, manganese, thallium and indeno(1,2,3-cd) pyrene in February 2008. The monitoring well installation log for MW-7 indicates that minor amounts of brick and glass were observed in the upper 5 feet of the boring. Approximately one-half of the screen interval was not logged due to a lack of sample recovery, with the other half noted as screened in a silty/organic material. The nearest test pit to MW-7 is TP-33 (approximately 350 feet to the north); waste materials noted at this location included concrete, rubber, bricks and plastic scraps. No potential industrial waste was observed during the excavation of TP-33 and PID readings recorded during excavation were all less than 10 ppm. The nearest soil sampling location to MW-7 is SS-66, located approximately 50 feet south of MW-7. The surface soil sample collected at SS-66 exhibited exceedances of Nonresidential SRSs for benzo(a)pyrene, arsenic, lead and PCBs. The nearest upgradient soil sampling location to MW-7 is SS-58. The surface soil sample collected at SS-58 exhibited exceedances of Nonresidential SRSs for aldrin, lead and PCBs. Based on these results, the source of indeno(1,2,3-cd)pyrene to groundwater at MW-7 is localized in groundwater at this location.

Exceedances of NJ GWQC at MW-10 were limited to one VOC (dichlorodifluoromethane), aluminum, arsenic, iron and manganese. The monitoring well installation log for MW-10 does not identify waste materials in the boring log and indicates that most of the material in the screened interval was clay. Dichlorodifluoromethane is a component of Freon and its presence in groundwater at monitoring well MW-10 appears to be related to old refrigerators, which are present on the ground nearby at POI-10. Low concentrations of CFCs were also observed in a surface soil sample collected at POI-10, but these concentrations did not exceed Residential or Nonresidential SRSs. Impacted groundwater at this well is considered localized.

The highest concentrations of constituents exceeding NJ GWQC were generally observed in groundwater collected from MW-3. Organic constituents detected at concentrations greater than NJ GWQC in MW-3 include benzene (both sampling events), bis(2-chloroethyl)ether (both sampling events) and three BHC pesticides (December 2007 sampling event). Inorganic constituents detected at concentrations greater than NJ GWQC in MW-3 include aluminum, arsenic, manganese and sodium during both sampling events. The monitoring well installation log for MW-3 indicates that waste materials were not observed in the boring and that the screened interval is completed in clay, silt and sand. Test pit TP-09 was excavated immediately adjacent to MW-3 and was identified as wet at the ground surface, which is consistent with the observations of water levels observed above the ground surface elevation at MW-3. Rusted drums and an oil boom were observed in TP-09 and a sheen and high PID reading were

observed at the interval from 4 to 6 feet below ground surface (bgs). One sample of potential industrial waste collected from TP-09 identified the presence of benzene at 20 mg/kg. The source of organic impacts in groundwater at MW-3 is likely the materials observed at TP-09.

Groundwater from MW-3 has the most constituents in excess of NJ GWQC. Exceedances of the NJ GWQC down gradient from MW-3 (at monitoring well MW-4) were limited to aluminum, iron and manganese. Only aluminum was detected at concentrations greater than the NJ GWQC during both sampling events at MW-4. This indicates that the extent of organic impacts in groundwater at MW-3 is localized. The impacts at MW-3 are related to the presence of potential industrial waste in nearby test pit TP-09. Based on the results of groundwater sampling at other monitoring well locations, the organic impacts in groundwater at MW-7 and MW-10 are also localized.

While shallow groundwater that flows through the landfill has the potential to flow into low-lying areas and/or surface-water bodies, water quality results from the ponds and the downstream portions of the Loantaka Brook and Black Brook indicate that the concentrations of VOCs, SVOCs and inorganic constituents are consistent with concentrations measured in surface-water samples upstream of the potential influence of the landfill. PCBs and pesticides were either not detected or were detected at concentrations lower than those observed in upstream portions of the surface-water bodies. This indicates that water from the landfill has not degraded the water quality in the surface-water bodies adjacent to the landfill.

Impacted groundwater in the materials overlying the clay likely flows laterally (the dominant direction of flow) at very low rates until reaching areas of discharge (low-lying areas or surface-water bodies). Vertical transport through the materials beneath the landfill is anticipated to be limited due to the presence of the glaciolacustrine clay that underlies the entire landfill. The presence of the clay means that lateral transport is the more significant transport direction instead of vertical.

c. Fate and Transport of Constituents

Fate and transport processes that describe the migration and attenuation of dissolved constituents in groundwater include advection, diffusion, sorption and degradation. Additionally, the fate and transport of inorganic constituents is a function of geochemical conditions that can create environments that limit or enhance their mobility. Likewise, different degradation reactions will occur under different geochemical conditions.

Advection refers to the bulk movement of constituents with groundwater. Diffusion is a mass transfer mechanism that refers to the movement of mass from the advective, flow-focusing features such as sands and gravels into less permeable clays and silts that act as storage reservoirs. This mass transfer occurs as a function of concentration gradients between the two types of materials, as well as physical characteristics of the units.

Sorption refers to the processes of absorption and adsorption, in which the organic matter provides specific binding sites that immobilize (adsorb) the dissolved molecules. Absorbed solute molecules partition between the aqueous and organic matter phase under assumed equilibrium conditions, and this serves to slow the velocity of a solute relative to the groundwater flow velocity. Adsorbed solute

molecules are effectively pinned in place and do not move freely through the binding matrix (Payne et al. 2008) and therefore represent a reduction in the mobile mass of solutes in groundwater.

At the landfill, estimates of groundwater velocity in the shallow water-bearing zone are fairly low with a range of 0.001 to 0.3 foot/day. It is important to note that the groundwater velocity is taken from the equivalent hydraulic conductivity, meaning that it represents the average behavior. As indicated above, groundwater and solute migration will occur in the more permeable sands and gravels and the silt and clay materials will not transmit significant volumes of water or solutes to any significant degree. Most of the VOCs detected in groundwater at the landfill will tend to sorb and be slowed via that mechanism, or will be diffused into and out of the low-permeability storage reservoirs as a function of concentration gradients. It is likely that constituents are not significantly migrating away from the landfill via advection.

The geochemical conditions can be either aerobic (oxidizing) or anaerobic (reducing) and each condition could be present within the landfill. Depending on which geochemical condition(s) are present within the groundwater, the mobility of certain dissolved-phase inorganics will be inhibited or enhanced. Likewise, degradation pathways (biological or chemical transformation of solutes) will be enhanced or inhibited based on geochemical conditions. For example, low concentrations of TCE detected in the December 2007 sampling event but not in the February 2008 sampling event, along with the presence of TCE degradation products (primarily cis-1,2-DCE and vinyl chloride) in both sampling events, is one line of evidence that the geochemical conditions within groundwater beneath the landfill are anaerobic or reducing because the transformation of TCE to these degradation products is favored under reducing conditions.

Due to the importance and relevance of geochemical conditions within landfills as related to the fate and transport of COCs, the following summary is provided to enhance the understanding of the mobility of inorganic constituents that exceed the NJ GWQC.

d. Groundwater Geochemical Conditions and Mobility of Inorganic Constituents

Inorganic constituents detected at concentrations greater than NJ GWQC during the most recent sampling event (i.e., February 2008) include the following:

- Aluminum (MW-3, MW-4, MW-5, MW-7, MW-8, X-2, X-3, X-4)
- Arsenic (MW-3, MW-10)
- Iron (MW-1, MW-2, MW-3, MW-4, MW-5, MW-6, MW-7, MW-8, MW-10, X-1, X-2, X-3, X-4, X-6)
- Lead (MW-7)
- Manganese (MW-1, MW-2, MW-3, MW-4, MW-5, MW-6, MW-7, MW-8, MW-9, MW-10, X-1, X-2)
- Sodium (MW-3, X-1)

- Thallium (MW-7).

Groundwater samples were unfiltered and represent total recoverable inorganic concentrations. The lowest concentrations of iron and manganese and generally higher concentrations of dissolved oxygen were identified at wells along the periphery of the landfill area (e.g., MW-4, MW-5, MW-8, X-2 through X-6). Higher concentrations of manganese and/or iron and generally lower concentrations of dissolved oxygen at wells were identified in the interior of the landfill area (e.g., MW-1, MW-2, MW-3, MW-6, MW-7). This may indicate suboxic groundwater conditions in the periphery of the landfill area and more reducing conditions in the interior of the landfill area. Because the samples were unfiltered, the results can also correlate to turbidity, with inorganic concentrations due to particles in the groundwater samples. For example, groundwater from monitoring well MW-3 exhibited the highest turbidity and relatively higher concentrations of iron, manganese and arsenic. Conversely, groundwater from monitoring well X-5 exhibited the lowest turbidity, low concentrations of iron and manganese and no detections of other inorganic constituents.

The mobility of inorganic constituents in groundwater may be controlled by many processes, including precipitation, sorption, complexation and redox reactions, and can be affected by pH, organic carbon and microbial processes (Violante et al. 2010). Reducing groundwater conditions may be created through microbial activity that results in the consumption of dissolved oxygen and nitrate, and the dissolution of iron and manganese minerals present in soil. Organic carbon serves as a source of electrons in these environments, and a series of electron acceptors (oxygen, nitrate, manganese, iron, sulfate) is used for microbial growth. Soil data indicate the presence of organic carbon at >10 to 20 percent TOC in the solid phase in many locations. Soil pH measured at the site ranged between 3.75 and 8.29 standard units, and groundwater pH ranged from 5.04 to 7.08 standard units.

Iron, Manganese and Aluminum

The concentrations of iron, manganese and aluminum exceeded NJ GWQC in groundwater samples collected during the February 2008 sampling event. Iron and manganese are abundant, naturally occurring elements in soil, with aluminum a major component of clay minerals and sand, and the groundwater samples were unfiltered. Geochemical conditions that can lead to the dissolution of iron and manganese minerals include a decrease in redox potential, as well as a change in ionic strength in groundwater. Natural organic carbon stimulates anaerobic microbial processes that result in reductive iron and manganese dissolution (Donahoe and Liu 1998). The iron and manganese are used as electron acceptors by naturally occurring microorganisms that metabolize the organic carbon. This natural process transforms insoluble ferric iron [Fe(III)] and Mn(IV) in solid phases to soluble ferrous iron Fe(II) and Mn(II). Organic carbon may be provided by hydrocarbons or VOCs, or natural organic matter present in the aquifer. High ionic strength in groundwater can lead to the dissolution of iron minerals, and some hydroxide minerals (aluminum, iron, manganese) and clay minerals are soluble under acidic conditions.

Arsenic

The concentration of arsenic exceeded the NJ GWQC in groundwater samples collected from monitoring wells MW-3 and MW-10 during the February 2008 sampling event. These locations are also associated with relatively high concentrations of manganese and iron and relatively high turbidity at MW-3. Arsenic

occurs naturally in soil as a trace element and is usually incorporated into iron minerals or sorbed to iron mineral surfaces. In this form, it is generally insoluble in groundwater at neutral pH, at moderate ionic strengths (e.g., sodium concentrations from 10 to 100 milligrams per liter) and under oxidizing conditions.

Certain geochemical conditions in groundwater can result in the mobilization of naturally occurring arsenic. These conditions include a decrease in redox potential (i.e., reducing conditions) generally associated with biogeochemical processes, and an increase in ionic strength (Smedley and Kinniburgh 2002). Microbial activity, stimulated by the presence of natural organic matter in groundwater, results in the dissolution of iron and release of arsenic incorporated into iron minerals or sorbed onto iron mineral surfaces. Reductive iron dissolution, with the transformation of insoluble Fe(III) to soluble Fe(II), is caused by the use of iron minerals by microorganisms for the metabolism of organic carbon. Electrons provided by the organic carbon are transferred to the iron minerals, resulting in reductive iron dissolution (Lovley and Phillips 1988). This promotes a decrease in the redox potential in the aquifer, and arsenic that is released from the iron is stabilized in a dissolved form. High groundwater ionic strength can also result in the release of naturally occurring arsenic that may be sorbed to iron minerals.

Lead

The concentration of lead exceeded the NJ GWQC in the groundwater sample collected from monitoring well MW-7, a location that exhibited potentially more reducing conditions, during the February 2008 sampling event. In general, the mobility of lead is not directly related to redox conditions; however, because lead may form stable precipitates with redox-sensitive elements such as sulfur, lead mobility may be indirectly related to redox conditions. In sulfate-reducing systems, lead is expected to form insoluble lead sulfide precipitates. In moderately reducing systems, reductive dissolution of iron oxides that contain adsorbed lead could result in lead mobilization. Under oxidizing conditions, lead solubility in aqueous solutions is highly pH dependent. In general, lead mineral solubility is low at near neutral to moderately alkaline pH, and higher at low pH or very high pH. Lead mobility is controlled primarily by adsorption, precipitation and complexation with organic matter. Lead is strongly adsorbed onto ferric oxides, hydrous oxides, aluminum oxides, oxyhydroxides and clay minerals in soil. Exceptions to this behavior are low-pH systems or environments with high concentrations of dissolved organic carbon, which may form stable, highly soluble complexes with lead.

Thallium

The concentration of thallium exceeded the NJ GWQC in the groundwater sample collected from monitoring well MW-7 during the February 2008 sampling event. Thallium sorbs to clay, organic matter, and iron and manganese oxides in soil, and is more mobile at low pH (WHO 1996). In highly reducing environments, thallium may precipitate as a sulfide.

3. Overview of the Landfill, Constituent Transport Processes and Constituent Distribution

As discussed above, the landfill consists of municipal solid waste. Some potential industrial wastes have been identified, but they are small in area and do not comprise a significant portion of the volume of the waste. This is expected based on the historical use of the landfill for disposal of municipal waste from

Chatham Township and nearby municipalities. The surface of the landfill in some areas is covered by a thin soil layer and/or vegetation; in other areas, municipal waste is visible at the ground surface.

VOCs, SVOCs, PCBs, pesticides and inorganic constituents are found in surface and subsurface soil collected from the landfill. Many of these constituents are likely components of the municipal waste. Some of the current uses of the landfill (hunting and the maintenance activities at the landscape areas) and the areas north of the landfill (shooting range) may also contribute to the constituents observed in environmental media. The pesticides at the landfill likely come from historical pesticide use to combat mosquitoes and rodents. Inorganic constituents, such as arsenic, lead, vanadium and others, are naturally occurring and their presence in the soil samples is at least partially due to their natural occurrence.

Precipitation that falls on the landfill transpires back to the atmosphere, recharges groundwater or runs off to the neighboring wetlands or surface-water bodies (i.e., the ponds, Loantaka Brook and Black Brook). The shallow groundwater beneath the site occurs in a thin, sandy and silty material that extends to 20 to 25 feet bgs. New Jersey regulation (N.J.A.C. 7:9D-2.3[a]) prohibits installation of potable wells with casings less than 50 feet in depth; therefore, no potable wells would be expected in the shallow water-bearing zone.

Two areas of impacted groundwater are observed in the shallow water-bearing zone (monitoring wells MW-3 and MW-10). Constituents observed at monitoring well MW-3 include VOCs such as benzene and may be related to VOC-impacted soil and drums located at nearby test pit TP-09. The VOC dichlorodifluoromethane, a component of Freon, was present in groundwater at monitoring well MW-10 and its presence appears to be related to old refrigerators, which are present on the ground nearby. Based on the absence of these constituents in nearby wells, the constituents found in groundwater at wells MW-3 and MW-10 are localized and not widespread.

The landfill and shallow water-bearing zone are underlain by a thick, continuous, plastic clay unit. RI soil borings indicate that this unit is at least 25 feet thick and literature values indicate that it is more than 100 feet thick and locally as much as 128 feet thick at the east end of the GSNWR (Minard 1967). This clay unit is a barrier to vertical groundwater flow and constituent migration, protecting the underlying water-bearing material. Given the relatively low levels of constituents in the shallow water-bearing zone beneath the landfill, the nearby availability of surface discharge areas, and the thickness and lack of permeability of the clay, impacts to groundwater beneath the clay unit are not expected.

Surface water and sediment in the ponds and streams (Loantaka Brook and Black Brook) on or adjacent to the landfill exhibit some constituents that are found at the landfill. Many of these constituents are also found in surface water and sediment upstream of the landfill. Therefore, their presence in the streams is at least in part due to sources upgradient of the landfill. The results of the semiquantitative comparison of upstream and downstream data and the distribution of exceedances of ARARs or EBSLs downstream of the landfill indicate that the downstream extent of constituents related to the landfill, if any, has been defined.

Key Physical Aspects of the Site

Summary of Hydrogeologic Conditions

The hydrostratigraphy underlying the landfill consists of a shallow water table saturated zone, comprising silt and sand deposits underlain by a layer of glaciolacustrine clay that serves as a confining unit to the geologic formations below. Ten new monitoring wells were installed in 2007 to characterize the hydrogeologic conditions in this shallow water-bearing zone. Monitoring well screens cross silt, sand and clay deposits, and in some cases, the landfilled materials.

The depth and extent of saturation of waste material varied widely across the landfill, based on observations during test pit excavation, soil boring advancement and monitoring well installation activities. In most of the soil borings and monitoring wells, the waste material was dry and the native material beneath the waste was saturated. Test pit excavation logs indicated that the depth to saturation ranged from the ground surface to beneath the waste material (if present) and in some instances saturation was not observed for the entire test pit depth. In areas where the waste material was observed to be saturated at the surface, saturation was likely from precipitation and/or overland flow.

Water likely flows vertically through the unsaturated waste materials with some small horizontal component, and upon reaching the saturated material, flows laterally with the natural groundwater flow patterns. Groundwater flow is expected to occur laterally through the sand and/or silty sand units. The groundwater flow in the shallow water-bearing zone above the clay is expected to be horizontal until reaching areas of discharge.

The presence of clay at the base of the soil borings and monitoring wells is evidence of the remnant glacial lake. The clay is grey in color with some brown or reddish brown intervals, cohesive, and plastic, with only a small proportion of silt or fine sand. At the deepest boring (SB-8), the top of the clay was 25 feet bgs and the clay continued to the bottom of the boring at 50 feet bgs with little to no change in its properties. This clay is continuous beneath the landfill, reported to be more than 100 feet thick and locally as much as 128 feet thick at the east end of the GSNWR (Minard 1967), and will restrict vertical flow and constituent migration into the aquifer below, and confines the underlying groundwater.

Identification of Data Gaps and Uncertainty

Data gaps in the understanding of site conditions are summarized below:

- The extent of certain constituents at concentrations above the New Jersey SRSs in soil in portions of the site is not fully delineated.
- The extent of certain constituents in groundwater at monitoring wells MW-3 and MW-10 is not fully delineated.
- Surface water and sediment in ponds on the landfill that were not previously sampled has not been characterized.

- The potential presence of certain VOCs in sediment pore water downgradient of monitoring well MW-10 has not been evaluated.

- Current constituent concentrations in groundwater are not known.

- The connection between groundwater and surface water in the small ponds at the northern boundary of the landfill has not been evaluated.

- Conditions at the existing Hunt Club well HC-1 have not been fully assessed.

QAPP Worksheet #11: Project/Data Quality Objectives

1. ***State the Problem***

   a. **Conceptual Site Model**: The Rolling Knolls Landfill Superfund Site is located in Chatham, New Jersey and was formerly a privately operated municipal waste landfill. The landfill was in use from the 1930s to 1966 and contains municipal and industrial waste. A more complete conceptual site model is provided in Worksheet #10.

   b. **Description of the Problem**: Data gaps sampling has been proposed to complete the delineation of contamination across the site. The main goals of this sampling are 1) to delineate the extent of certain constituents (VOCs, SVOCs, pesticides, PCB Aroclors, PCB congeners, dioxins and furans, and metals and cyanide) in soil, groundwater, pore water, and surface water, 2) to measure the current concentrations of constituents in groundwater, 3) to investigate the connection between surface water and groundwater, and 4) to assess conditions at the Hunt Club well. These data gaps were identified by the USEPA following the completion of the Site Characterization Summary Report (SCSR). Additional data collected during this sampling will be used to further characterize the site and will be included in the evaluation of potential risk to ecological receptors that will be investigated in the BERA.

Planning Team Members and Decision Makers

Planning team members and decision makers include the following:

- existing project team members who are familiar with the site and the results of previous investigations;
- geologists, environmental scientists, and engineers;
- representatives of the Settling Parties who have agreed to conduct the Remedial Investigation and Feasibility Study at the site; and
- representatives of the USEPA.

Available Resources and Relevant Deadlines

The Settling Parties will ensure that adequate resources are available for sample collection, sample analysis, data evaluation, and report preparation. Relevant deadlines are:

- Samples will be collected in two phases. The first phase, including surface water, sediment, pore water, and temporary groundwater well data, will be completed in November 2014. The second phase, including permanent groundwater well data, will be completed in May 2015.

- The Scope of Work in the Administrative Settlement Agreement and Order on Consent between the Settling Parties and USEPA (September 30, 2005) allows 60 days for report preparation and submittal of the Data Gaps SAP report after receipt of the validated data.

2. *Identify the Goals of the Study*

The goal of this study is to address all remaining data gaps identified by the USEPA following the approval of the SCSR and to constrain the fate and transport of chemical constituents (see Worksheet #10 for greater detail on chemical constituents). This will allow for evaluation of potential risks to ecological receptors.

- Further delineate the extent of constituents that were present at concentrations above the New Jersey SRSs in soil in portions of the site.

- Delineate the extent (downgradient) of VOCs observed in the shallow water-bearing zone in the western and southwestern portions of the site (monitoring wells MW-3 and MW-10), which is likely related to VOC-impacted soil and drums.

- Characterize surface water and sediment in ponds on the landfill that were not previously sampled.

- Investigate the potential presence of VOCs in pore water downgradient of well MW-10.

- Obtain a full round of groundwater samples from all monitoring wells to characterize the current constituent concentrations in groundwater.

- Investigate the connection between groundwater and surface water in the small ponds at the northern landfill boundary.

- Assess conditions at the existing Hunt Club well HC-1.

Principle study question: What is the extent of chemical constituents in the Rolling Knolls Landfill and how are groundwater, surface water and soil communicating in different areas of the site to produce the observed contamination?

Alternative Actions

Results of Comparison to the Site Characterization Summary Report	Alternative Action
Contaminants are consistent with concentrations reported in the Site Characterization Summary Report and those used in the Human Health Risk Assessment.	Complete the Data Gaps report, and implement the BERA. Reevaluate the results of the Human Health Risk Assessment.
Contaminants exceed concentrations of the SRS, Site Characterization Summary Report and those used in the Human Health Risk Assessment.	Complete the Data Gaps report, and implement the BERA. Reevaluate the results of the Human Health Risk Assessment. Consider additional sampling to be incorporated with any necessary BERA sampling or in a pre-design investigation.
Contaminant concentrations are inconsistent with previous sampling and conceptual site model.	Recommend additional sampling.

Decision Statement

Determine whether concentrations in soil, sediment, surface water, groundwater, and pore water indicate concentrations above regulatory limits and/or acceptable risk levels for human and ecological exposures.

If soil, groundwater, pore water, surface water and/or sediment constituents exceed concentrations determined for the SCSR and changes to the Human Health Risk Assessment (CDM, June 2014) are suspected, then the Human Health Risk Assessment may be re-evaluated. These data will also be used to update the Screening-Level Ecological Risk Assessment refinements that will be evaluated prior to conducting the BERA.

3. *Identify Information Inputs*

Type of information needed:

Analytical results for environmental samples

- Soil samples: will be used to delineate the extent of constituents associated with the landfill that are present at levels above their SRS.
- Groundwater samples from temporary monitoring wells: will be used to identify potential sources of VOCs around permanent monitoring wells MW-10 and MW-3.
- Groundwater samples from permanent wells: will be used to characterize current constituent concentrations.

- Pore-water samples: delineate constituents in groundwater that are migrating to surface water downgradient of well MW-10.

- Groundwater level measurements in permanent and temporary well: will be used to constrain the local hydrogeology and groundwater flow directions.

- Surface-water and sediment samples: will be used to characterize small bodies of water that have not previously been sampled.

Field observations

During sample collection, the field teams will observe and make note of the conditions at the Site and observe the presence of surface water bodies, the terrain, and the wildlife present. The field teams will also take PID readings during drilling and well cap removal.

Source of information:

The required information will be obtained by sample collection and analysis, and will be supported by existing information on the site.

Information Needed to Meet Performance Criteria

Performance Criteria	Information Need to Meet Performance Criteria
Use of approved sampling procedures	Field notes and sample logs
Collecting an adequate sample volume	Field notes and laboratory notes
Collecting an adequate number of samples	Field notes; comparison of laboratory results report to work plan
Proper sample packing, shipping, and handling	Field notes and laboratory notes
Appropriate analytical procedures	Laboratory notes in analytical results report; all data will be validated.

4. *Define the Boundaries of the Study*

Geographic Area

The geographic area of the study is the Rolling Knolls Landfill and adjacent areas, including areas in the GSNWR. The depth of the study is to approximately 15 feet bgs, which is anticipated to be the approximate depth of temporary and permanent monitoring wells. In addition, the study includes evaluation of the existing Hunt Club supply well, the depth of which is unknown.

Time Frame for Collecting the Data

This study includes collection of soil, sediment, groundwater, surface water and pore water. Sampling is proposed to begin in October when the temperatures will be moderate but the brush will begin to die back increasing visibility and site accessibility. The initial phase of field investigation should be completed in November 2014. Data will be evaluated over the winter, and the second phase of investigation (installation and sampling of permanent monitoring wells) will be implemented in April and May 2015, before vegetation has reached its full size.

The data will provide a current picture of site conditions, suitable for the risk assessments and feasibility study which will be completed when this investigation is complete.

Appropriate Scale for Decision Making

The purpose of the data gaps sampling is to target specific areas of the site that need further evaluation (See Data Gaps Sampling and Analysis Plan and Worksheets # 17 and 18). Soil, and sediment results represent the local area of the sample. Surface water, pore water, and groundwater results represent the area local to the sampling point, but because the water flows, the results also represent upgradient areas and can be used to estimate potential future impacts to downgradient areas.

5. *Develop the Analytic Approach*

Population Parameters

For delineation, individual soil and groundwater sample results will be compared to state regulatory standards.

For risk assessments, the data will be segregated by exposure pathway (for example, surface water). Maximum and 95 percent upper confidence limit concentrations of the data will be compared to the appropriate risk screening level.

Action Levels

The action levels for soil, surface water, and groundwater data are contained in N.J.A.C. 7:26D, Remediation Standards. In addition, the data will be used in risk assessments for comparison to the appropriate risk screening levels.

6. *Specify Performance or Acceptance Criteria.*

The sampling program covered by this QAPP has been developed to address certain data gaps in the investigation previously described in the SCSR, which was approved by the USEPA. This sampling is not the only or entire effort to characterize the site. The scope of sampling and analysis was determined by the Settling Parties and the USEPA project team to answer specific

and limited questions about the site. Therefore, the statistical analysis proposed in the USEPA guidance (USEPA, February 2006) is not applicable to this scope of sampling.

For acceptance criteria, it is expected that representative, valid data will be obtained from at least 90% of the proposed sample locations. Field conditions, such as a lack of groundwater in certain monitoring wells, access restrictions, or other conditions, may limit the completion of sampling at certain proposed sample locations. To the extent practical, sample locations will be relocated as needed to ensure completion of the proposed sampling. However, at some locations, an alternative location may not be available.

7. ***Develop the Detailed Plan for Obtaining Data.***

In its letter of March 7, 2013, the USEPA identified several data gaps related to the delineation of constituents in environmental media (USEPA 2013). To address these data gaps, ARCADIS prepared a Preliminary Plan to Address Data Gaps (April 30, 2013; ARCADIS 2013). The work proposed in this Preliminary Plan was to be conducted during the design of the site remedy. However, during subsequent scoping of the BERA, USEPA offered the Group the option of assessing the data gaps before implementing the BERA so that the additional data could be used in scoping the BERA (USEPA letter of July 30, 2014; USEPA 2014). The objectives of the data gaps sampling, as described in item 3 above and in Worksheet #17, were to further characterize constituents in soil, groundwater, pore water, surface water, and sediment.

A complete Data Gaps Sampling and Analysis Plan (SAP) developed in conjunction with USEPA has been prepared to detail the sampling and analyses proposed to for the data gaps investigation. This SAP has been submitted to the USEPA and is currently under review.

QAPP Worksheet #12: Measurement Performance Criteria

Quality Assurance Project Plan Worksheet #12-1 – Measurement Performance Criteria (Semivolatile Organic Compounds in Water by SOM01.2 and SOM01.2-SIM)

Matrix	Water
Analytical Group	SVOCs
Concentration Level	All

Sampling Procedure[1]	Analytical Method/Standard Operating Procedure (SOP)[2]	Data Quality Indicators (DQIs)	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
SOP 2, SOP 7, SOP 8, SOP 20	SOM01.2/SOM01.2-SIM/TAB-3	Precision – Overall	Relative percent difference (RPD) < 35%	Field duplicate	S&A
		Accuracy/Bias	% Relative abundance, see SOM01.2 – Exhibit D Semivolatiles Table 1	Instrument performance check: decafluorotriphenylphosphine (DFTPP)	A
		Accuracy/Bias Contamination	All target compounds < Contract Required Quantitation Limit (CRQL)	Blanks (field, equipment, method)	S&A
		Accuracy/Bias	Percent recovery (%R), see see SOM01.2 – Exhibit D Semivolatiles Tables 6 (%),7 (associated target compounds), and 8 (associated target compounds, SIM)	Deuterated monitoring compounds (DMC)	A
		Accuracy/Bias	%R, see see SOM01.2 – Exhibit D Semivolatiles Table 5	Matrix spike (MS)[3]	A
		Accuracy/Bias	%R, see see SOM01.2 – Exhibit D Semivolatiles Table 5	Matrix spike duplicate (MSD)[3]	A
		Precision	%RPD, see see SOM01.2 – Exhibit D Semivolatiles Table 5	MS/MSD[3]	A

Quality Assurance Project Plan Worksheet #12-1 – Measurement Performance Criteria (Semivolatile Organic Compounds in Water by SOM01.2 and SOM01.2-SIM)

Matrix	Water
Analytical Group	SVOCs
Concentration Level	All

Sampling Procedure[1]	Analytical Method/Standard Operating Procedure (SOP)[2]	Data Quality Indicators (DQIs)	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
		Precision	Area response 50.0% to 200% and retention time (RT) ±30.0 seconds from associated 12-hour calibration standard; see SOM01.2 – Exhibit D Semivolatiles Table 2 (associated target compounds)	Internal standard	A

Notes:
[1] Reference number from Quality Assurance Project Plan Worksheet #21.
[2] Reference number from Quality Assurance Project Plan Worksheet #23.
[3] MS and MSD must be client-provided.

Quality Assurance Project Plan Worksheet #12-2 – Measurement Performance Criteria (Volatile Organic Compounds in Water by SOM01.2)

Matrix	Water
Analytical Group	VOCs
Concentration Level	All

Sampling Procedure[1]	Analytical Method/Standard Operating Procedure (SOP)[2]	Data Quality Indicators (DQIs)	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
SOP 2, SOP 7, SOP 8, SOP 20	SOM01.2/TAB-11	Precision – Overall	Relative percent difference (RPD) < 35%	Field duplicate	S&A
		Accuracy/Bias	% Relative abundance, see SOM01.2 – Exhibit D Low/Medium Volatiles Table 1	Instrument performance check: bromofluorobenzene (BFB)	A
		Accuracy/Bias Contamination	All target compounds < Contract Required Quantitation Limit (CRQL)	Blanks (trip, field, equipment, method)	S&A
		Accuracy/Bias	Percent recovery (%R), see SOM01.2 – Exhibit D Low/Medium Volatiles Table 5 (%R) and Table 7 (associated target compounds)	Deuterated monitoring compounds (DMC)	A
		Accuracy/Bias	%R, see SOM01.2 – Exhibit D Low/Medium Volatiles Table 6	Matrix spike (MS)[3]	A
		Accuracy/Bias	%R, see SOM01.2 – Exhibit D Low/Medium Volatiles Table 6	Matrix spike duplicate (MSD)[3]	A
		Precision	%RPD, see SOM01.2 – Exhibit D Low/Medium Volatiles Table 6	MS/MSD[3]	A
		Precision	Area response 50.0% to 200% and retention time (RT) ±30.0 seconds from associated 12-hour calibration standard; see SOM01.2 – Exhibit D Low/Medium Volatiles Table 3 (associated target compounds)	Internal standard	A

Notes:
[1] Reference number from Quality Assurance Project Plan Worksheet #21.
[2] Reference number from Quality Assurance Project Plan Worksheet #23.
[3] MS and MSD must be client-provided.

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Quality Assurance Project Plan Worksheet #12-3 – Measurement Performance Criteria (Pesticides in Water by SOM01.2)

Matrix	Water
Analytical Group	Pesticides
Concentration Level	All

Sampling Procedure[1]	Analytical Method/SOP[2]	DQIs	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
SOP 2, SOP 7, SOP 8, SOP 20	SOM01.2/TAB-2	Precision – Overall	RPD < 35%	Field duplicate	S&A
		Accuracy/Bias Contamination	< CRQL	Blanks (field, equipment, method, instrument)	S&A
		Accuracy/Bias	%R: 30-150%	Surrogate spikes: tetrachloro-m-xylene (TCX) and decachlorobiphenyl (DCB)	A
		Accuracy/Bias	%R, see SOM01.2 – Exhibit D Pesticides Table 3	MS[3]	A
		Accuracy/Bias	%R, see SOM01.2 – Exhibit D Pesticides Table 3	MSD[3]	A
		Precision	%RPD, see SOM01.2 – Exhibit D Pesticides Table 3	MS/MSD[3]	A
		Accuracy/Bias	%R, see SOM01.2 – Exhibit D Pesticides Table 2	LCS	A
		Accuracy/Bias and Precision	Retention times, see SOM01.2 – Exhibit D Pesticides Table 1	Retention time windows	A

Notes:
[1] Reference number from Quality Assurance Project Plan Worksheet #21.
[2] Reference number from Quality Assurance Project Plan Worksheet #23.
[3] MS and MSD analysis must be client-provided.

Quality Assurance Project Plan Worksheet #12-4 – Measurement Performance Criteria (Polychlorinated Biphenyls (PCBs) in Water by SOM01.2)

Matrix	Water
Analytical Group	PCBs
Concentration Level	All

Sampling Procedure[1]	Analytical Method/SOP[2]	DQIs	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
SOP 2, SOP 7, SOP 8, SOP 20	SOM01.2/TAB-1	Precision – Overall	RPD < 35%	Field duplicate	S&A
		Accuracy/Bias Contamination	< CRQL	Blanks (field, equipment, method, instrument)	S&A
		Accuracy/Bias	%R: 30-150%	Surrogate spikes: tetrachloro-m-xylene (TCX) and decachlorobiphenyl (DCB)	A
		Accuracy/Bias	%R, see SOM01.2 – Exhibit D Aroclors Table 1	MS[3]	A
		Accuracy/Bias	%R, see SOM01.2 – Exhibit D Aroclors Table 1	MSD[3]	A
		Precision	%RPD, see SOM01.2 – Exhibit D Aroclors Table 1	MS/MSD[3]	A
		Accuracy/Bias	%R, see SOM01.2 – Exhibit D Aroclors Table 2	LCS	A
		Accuracy/Bias and Precision	Retention times, see analytical SOP	Retention time windows	A

Notes:

[1] Reference number from Quality Assurance Project Plan Worksheet #21.

[2] Reference number from Quality Assurance Project Plan Worksheet #23.

[3] MS and MSD analysis must be client-provided.

Quality Assurance Project Plan Worksheet #12-5 – Measurement Performance Criteria (Metals, Mercury, and Cyanide in Water by ISM01.3)

Matrix	Water
Analytical Group	Metals/Mercury/Cyanide
Concentration Level	All

Sampling Procedure[1]	Analytical Method/SOP[2]	DQIs	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
SOP 2, SOP 7, SOP 8, SOP 20	ISM01.3/TAB-5, TAB-6, TAB-7	Precision – Overall	RPD < 35%	Field duplicate	S&A
		Accuracy/Bias Contamination	< CRQL	Blanks (field, equipment, calibration, method)	S&A
		Precision	RPD < 20% for original and duplicate sample values ≥5x the CRQL; control limit of the CRQL used if either the sample or duplicate value is <5x the CRQL	Matrix duplicate (MD)[3]	A
		Accuracy/Bias	%R: 75-125%; does not apply when the sample concentration is ≥4x the spike added	MS[3]	A
		Precision – lab	Percent recovery (%R) ±20% of true value	Interference check sample (A and AB) (ICP metals analysis only)	A
		Accuracy/Bias	%R 70-130% (50-150% for antimony and silver)	Laboratory control sample (LCS) (ICP metals analysis only)	A
		Precision	Percent difference (%D) < 10%	Serial dilution (ICP metals analysis only)[4]	A

Notes:

[1] Reference number from Quality Assurance Project Plan Worksheet #21.

[2] Reference number from Quality Assurance Project Plan Worksheet #23.

[3] MD and MS must be client-provided.

[4] Performed as needed only for analytes with concentration > 50 times the method detection limit (MDL).

Quality Assurance Project Plan Worksheet #12-6 – Measurement Performance Criteria (Mercury in Water by EPA 1631E)

Matrix	**Water**
Analytical Group	**Mercury**
Concentration Level	**Low**

Sampling Procedure[1]	Analytical Method/SOP[2]	DQIs	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
SOP 2, SOP 7, SOP 8, SOP 20	EPA 1613E/TANC-12	Precision – Overall	RPD < 35%	Field duplicate	S&A
		Accuracy/Bias Contamination	< RL	Blanks (field, equipment, calibration, method)	S&A
		Precision	RPD < method specified limit	Matrix duplicate (MD)[3]	A
		Accuracy/Bias	%R, method specified limit	MS[4]	A
		Accuracy/Bias	%R, method specified limit	Continuing calibration verification	A
		Accuracy/Bias	%R, method specified limit	Laboratory control sample	A

Notes:

[1] Reference number from Quality Assurance Project Plan Worksheet #21.

[2] Reference number from Quality Assurance Project Plan Worksheet #23.

[3] MD and MS must be client-provided.

Quality Assurance Project Plan Worksheet #12-7 – Measurement Performance Criteria (Semivolatile Organic Compounds in Soil and Sediment by SOM01.2 and SOM01.2-SIM)

Matrix	Soil/Sediment
Analytical Group	SVOCs
Concentration Level	All

Sampling Procedure[1]	Analytical Method/Standard Operating Procedure (SOP)[2]	Data Quality Indicators (DQIs)	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
SOP 5, SOP 14	SOM01.2/SOM01.2-SIM/TAB-3	Precision – Overall	Relative percent difference (RPD) < 50%	Field duplicate	S&A
		Accuracy/Bias	% Relative abundance, see SOM01.2 – Exhibit D Semivolatiles Table 1	Instrument performance check: decafluorotriphenylphosphine (DFTPP)	A
		Accuracy/Bias Contamination	All target compounds < Contract Required Quantitation Limit (CRQL)	Blanks (field, equipment, method)	S&A
		Accuracy/Bias	Percent recovery (%R), see see SOM01.2 – Exhibit D Semivolatiles Tables 6 (%),7 (associated target compounds), and 8 (associated target compounds, SIM)	Deuterated monitoring compounds (DMC)	A
		Accuracy/Bias	%R, see see SOM01.2 – Exhibit D Semivolatiles Table 5	Matrix spike (MS)[3]	A
		Accuracy/Bias	%R, see see SOM01.2 – Exhibit D Semivolatiles Table 5	Matrix spike duplicate (MSD)[3]	A
		Precision	%RPD, see see SOM01.2 – Exhibit D Semivolatiles Table 5	MS/MSD[3]	A
		Precision	Area response 50.0% to 200% and retention time (RT) ±30.0 seconds from associated 12-hour calibration standard; see SOM01.2 – Exhibit D Semivolatiles Table 2 (associated target compounds)	Internal standard	A

Notes:
[1] Reference number from Quality Assurance Project Plan Worksheet #21.
[2] Reference number from Quality Assurance Project Plan Worksheet #23.
[3] MS and MSD must be client-provided.

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Quality Assurance Project Plan Worksheet #12-8 – Measurement Performance Criteria (Volatile Organic Compounds in Soil and Sediment by SOM01.2)

Matrix	Soil/Sediment
Analytical Group	VOCs
Concentration Level	All

Sampling Procedure[1]	Analytical Method/Standard Operating Procedure (SOP)[2]	Data Quality Indicators (DQIs)	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
SOP 5, SOP 14	SOM01.2/TAB-4	Precision – Overall	Relative percent difference (RPD) < 50%	Field duplicate	S&A
		Accuracy/Bias	% Relative abundance, see SOM01.2 – Exhibit D Low/Medium Volatiles Table 1	Instrument performance check: bromofluorobenzene (BFB)	A
		Accuracy/Bias Contamination	All target compounds < Contract Required Quantitation Limit (CRQL)	Blanks (trip, field, equipment, method)	S&A
		Accuracy/Bias	Percent recovery (%R), see SOM01.2 – Exhibit D Low/Medium Volatiles Table 5 (%R) and Table 7 (associated target compounds)	Deuterated monitoring compounds (DMC)	A
		Accuracy/Bias	%R, see SOM01.2 – Exhibit D Low/Medium Volatiles Table 6	Matrix spike (MS)[3]	A
		Accuracy/Bias	%R, see SOM01.2 – Exhibit D Low/Medium Volatiles Table 6	Matrix spike duplicate (MSD)[3]	A
		Precision	%RPD, see SOM01.2 – Exhibit D Low/Medium Volatiles Table 6	MS/MSD[3]	A
		Precision	Area response 50.0% to 200% and retention time (RT) ±30.0 seconds from associated 12-hour calibration standard; see SOM01.2 – Exhibit D Low/Medium Volatiles Table 3	Internal standard	A

Quality Assurance Project Plan Worksheet #12-8 – Measurement Performance Criteria (Volatile Organic Compounds in Soil and Sediment by SOM01.2)

Matrix	Soil/Sediment
Analytical Group	VOCs
Concentration Level	All

Sampling Procedure[1]	Analytical Method/Standard Operating Procedure (SOP)[2]	Data Quality Indicators (DQIs)	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
			(associated target compounds)		

Notes:
[1] Reference number from Quality Assurance Project Plan Worksheet #21.
[2] Reference number from Quality Assurance Project Plan Worksheet #23.
[3] MS and MSD must be client-provided.

Quality Assurance Project Plan Worksheet #12-9 – Measurement Performance Criteria (Pesticides in Soil and Sediment by SOM01.2)

Matrix	Soil/Sediment
Analytical Group	Pesticides
Concentration Level	All

Sampling Procedure[1]	Analytical Method/SOP[2]	DQIs	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
SOP 5, SOP 14	SOM01.2/TAB-2	Precision – Overall	RPD < 50%	Field duplicate	S&A
		Accuracy/Bias Contamination	< CRQL	Blanks (field, equipment, method, instrument)	S&A
		Accuracy/Bias	%R: 30-150%	Surrogate spikes: tetrachloro-m-xylene (TCX) and decachlorobiphenyl (DCB)	A
		Accuracy/Bias	%R, see SOM01.2 – Exhibit D Pesticides Table 3	MS[3]	A
		Accuracy/Bias	%R, see SOM01.2 – Exhibit D Pesticides Table 3	MSD[3]	A
		Precision	%RPD, see SOM01.2 – Exhibit D Pesticides Table 3	MS/MSD[3]	A
		Accuracy/Bias	%R, see SOM01.2 – Exhibit D Pesticides Table 2	LCS	A
		Accuracy/Bias and Precision	Retention times, see SOM01.2 – Exhibit D Pesticides Table 1	Retention time windows	A

Notes:
[1] Reference number from Quality Assurance Project Plan Worksheet #21.
[2] Reference number from Quality Assurance Project Plan Worksheet #23.
[3] MS and MSD analysis must be client-provided.

Quality Assurance Project Plan Worksheet #12-10 – Measurement Performance Criteria (Polychlorinated Biphenyls (PCBs) in Soil and Sediment by SOM01.2)

Matrix	Soil/Sediment
Analytical Group	PCBs
Concentration Level	All

Sampling Procedure[1]	Analytical Method/SOP[2]	DQIs	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
SOP 5, SOP 14	SOM01.2/TAB-1	Precision – Overall	RPD < 50%	Field duplicate	S&A
		Accuracy/Bias Contamination	< CRQL	Blanks (field, equipment, method, instrument)	S&A
		Accuracy/Bias	%R: 30-150%	Surrogate spikes: tetrachloro-m-xylene (TCX) and decachlorobiphenyl (DCB)	A
		Accuracy/Bias	%R, see SOM01.2 – Exhibit D Aroclors Table 1	MS[3]	A
		Accuracy/Bias	%R, see SOM01.2 – Exhibit D Aroclors Table 1	MSD[3]	A
		Precision	%RPD, see SOM01.2 – Exhibit D Aroclors Table 1	MS/MSD[3]	A
		Accuracy/Bias	%R, see SOM01.2 – Exhibit D Aroclors Table 2	LCS	A
		Accuracy/Bias and Precision	Retention times, see analytical SOP	Retention time windows	A

Notes:
[1] Reference number from Quality Assurance Project Plan Worksheet #21.
[2] Reference number from Quality Assurance Project Plan Worksheet #23.
[3] MS and MSD analysis must be client-provided.

Quality Assurance Project Plan Worksheet #12-11 – Measurement Performance Criteria (Metals, Mercury, and Cyanide in Soil and Sediment by ISM01.3)

Matrix	Soil/Sediment
Analytical Group	Metals/Mercury/Cyanide
Concentration Level	All

Sampling Procedure[1]	Analytical Method/SOP[2]	DQIs	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
SOP 5, SOP 14	ISM01.3/TAB-5, TAB-6, TAB-7	Precision – Overall	RPD < 50%	Field duplicate	S&A
		Accuracy/Bias Contamination	< CRQL	Blanks (field, equipment, calibration, method)	S&A
		Precision	RPD < 20% for original and duplicate sample values ≥5x the CRQL; control limit of the CRQL used if either the sample or duplicate value is <5x the CRQL	Matrix duplicate (MD)[3]	A
		Accuracy/Bias	%R: 75-125%; does not apply when the sample concentration is ≥4x the spike added	MS[3]	A
		Precision – lab	Percent recovery (%R) ±20% of true value	Interference check sample (A and AB) (ICP metals analysis only)	A
		Accuracy/Bias	%R 70-130% (50-150% for antimony and silver)	Laboratory control sample (LCS) (ICP metals analysis only)	A
		Precision	Percent difference (%D) < 10%	Serial dilution (ICP metals analysis only)[4]	A

Notes:
[1] Reference number from Quality Assurance Project Plan Worksheet #21.
[2] Reference number from Quality Assurance Project Plan Worksheet #23.
[3] MD and MS must be client-provided.
[4] Performed as needed only for analytes with concentration > 50 times the method detection limit (MDL).

QAPP Worksheet #12-12 Measurement Performance Criteria (Total Organic Carbon in Soil and Sediment by Lloyd Kahn)

Matrix	Soil/Sediment
Analytical Group	TOC
Concentration Level	All

Sampling Procedure[1]	Analytical Method/SOP[2]	DQIs	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
SOP 5, SOP 14	Lloyd Kahn/TAB-9	Precision — Overall	RPD < 50%	Field duplicate	S&A
		Accuracy/Bias	%R, laboratory generated limits	LCS	A
		Accuracy/Bias Contamination	< RL	Blanks (field, equipment, method)	S&A
		Accuracy/Bias	%R, laboratory generated limits	Matrix Spike (MS)[3]	A
		Precision	RPD, laboratory generated limits	MS/MSD or Laboratory Duplicate[3]	A

Notes:
[1] Reference number from QAPP Worksheet #21.
[2] Reference number from QAPP Worksheet #23.
[3] Sufficient sample size for MS and laboratory duplicate analysis must be client-provided.

Quality Assurance Project Plan Worksheet #12-13 – Measurement Performance Criteria (PCB Congeners in Soil and Sediment by EPA 1668A)

Matrix	Soil/Sediment
Analytical Group	PCB Congeners
Concentration Level	All

Sampling Procedure[1]	Analytical Method/SOP[2]	DQIs	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
SOP 5, SOP 14	EPA 1668A/TAWS-1	Precision – Overall	RPD < 50%	Field duplicate	S&A
		Accuracy/Bias	%R, method specified limit	Labeled Compounds/Internal Standard	A
		Accuracy/Bias Contamination	< RL	Blanks (field, equipment, method)	S&A
		Accuracy/Bias	%R, method specified limit	OPR/LCS	A
		Accuracy/Bias	%R, method specified limit	MS[3]	A
		Accuracy/Bias	%R, method specified limit	MSD or LCSD[3]	A
		Precision	RPD, method specified limit	MS/MSD or LCS/LCSD [3]	A

Notes:
[1]Reference number from Quality Assurance Project Plan Worksheet #21.
[2]Reference number from Quality Assurance Project Plan Worksheet #23.
[3]Sufficient sample size for MS and MSD analysis must be client-provided. LCS/LCSD performed when no MS/MSD are supplied.

Quality Assurance Project Plan Worksheet #12-14 – Measurement Performance Criteria (Dioxins and Furans in Soil and Sediment by EPA 1613)

Matrix	Soil/Sediment
Analytical Group	Dioxins and Furans
Concentration Level	All

Sampling Procedure[1]	Analytical Method/ Standard Operating Procedure (SOP)[2]	Data Quality Indicators (DQIs)	Measurement Performance Criteria	Quality Control (QC) Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
SOP 5, SOP 14	EPA 1613/TAWS-2	Precision – Overall	Relative percent difference (RPD) < 50%	Field duplicate	S&A
		Precision	Percent recovery (%R), method specified limit	Labeled Compounds/Internal Standard	A
		Accuracy/Bias Contamination	< RL	Blanks (field, equipment, method)	S&A
		Accuracy/Bias	%R, method specified limit	Laboratory control sample (LCS) and laboratory control sample duplicate (LCSD)[3]	A
		Accuracy/Bias and Precision	Method specified limit	Instrument performance check: Perfluorokerosene (PKF)	A
		Precision	%RPD method specified limit	LCS/LCSD	A

Notes:
[1]Reference number from Quality Assurance Project Plan Worksheet #21.
[2]Reference number from Quality Assurance Project Plan Worksheet #23.

QAPP Worksheet #13: Secondary Data Uses and Limitations

Data type	Source	Data uses relative to current project	Factors affecting the reliability of data and limitations on data use
Visual observation of surface water bodies	Field personnel	Better describe the occurrence of surface water in wetlands areas, potentially including observations of bed and back morphology, and when/if surface water is present.	Observations will be made concurrent with sampling so will not include all areas of the landfill, and will be limited in duration.
Visual observation of landfill materials and soil	Field personnel	Add to our understanding of waste materials in the landfill, and the thickness/quality of soil cover.	Observations will be made concurrent with sampling so will not include all areas of the landfill.
Field screening data of monitoring and temporary wells with PID	Field personnel	Add to our understanding of the volatiles that are concentrated in the headspace of the well over time.	Observations will be made concurrent with sampling so will not include all areas of the landfill. This method may also have varying consistency due to tightness of the well cap.

QAPP Worksheet #14/16: Project Tasks & Schedule

Activity	Responsible party	Planned start date	Planned completion date	Deliverable(s)	Deliverable due date
Mobilization	ARCADIS	13 October 2014	13 October 2014	Field notes	13 October 2014
Vegetation clearing	ARCADIS	13 October 2014	14 October 2014	Field notes	13 October 2014
Underground utility clearing	ARCADIS	14 October 2014	14 October 2014	Field notes of New Jersey One-Call utility mark outs	14 October 2014
Sample collection – soil	ARCADIS	20 October 2014	31 October 2014	Field notes, map of boring locations, and soil logs	28 October 2014
Installation of temporary monitoring wells	ARCADIS	27 October 2014	28 October 2014	Field notes, map of well locations, and soil logs	29 October 2014
Sample collection – groundwater from temporary and permanent wells	ARCADIS	28 October 2014	31 October 2014	Field notes, groundwater purge logs, and chain of custodies	3 November 2014
Installation of pore water samplers	ARCADIS	29 October 2014	29 October 2014	Field notes and chain of custodies	1 November 2014
Sample collection – pore water	ARCADIS	12 November 2014	12 November 2014	Field notes and chain of custodies	19 November 2014
Sample collection – surface water and sediment	ARCADIS	27 October 2014	31 October 2014	Field notes and chain of custodies	3 November 2014

Activity	Responsible party	Planned start date	Planned completion date	Deliverable(s)	Deliverable due date
Assess Hunt Club Well HC-1	ARCADIS	22 October 2014	22 October 2014	Field notes, groundwater purge logs, and chain of custodies	29 October 2014
Analysis of Phase One samples	TestAmerica	22 October 2014	10 December 2014	Report of Analyses/Data package	10 December 2014
Validation of Phase One data	ARCADIS	10 December 2014	17 January 2015	Validation Summary report	17 January 2015
Usability assessment	Project Team	December 2014	December 2014	Meeting minutes/Usability assessment summary report	December 2014
Preparation of Interim Technical Memo	ARCADIS	3 November 2014	5 January 2015	Interim Technical Memorandum	5 January 2015
USEPA review and approval of Interim Technical Memorandum	USEPA	6 January 2015	27 January 2015	Approval of proposed permanent monitoring well locations	28 January 2015
Obtain well permits	ARCADIS	29 January 2015	28 February 2015	Permit approvals	28 February 2015
Install and develop permanent wells	ARCADIS	2 March 2015	11 March 2015	Field notes and well logs	24 March 2015
Redevelop existing wells	ARCADIS	12 March 2015	17 March 2015	Field notes	18 March 2015
First groundwater sampling event (all new and existing wells)	ARCADIS	6 April 2015	17 April 2015	Field notes and purge logs	24 April 2015
Second groundwater sampling event (all new wells)	ARCADIS	18 May 2015	22 May 2015	Field notes and purge logs	29 May 2015
Groundwater sample	TestAmerica	7 April 2015	12 June 2015	Laboratory data	12 June 2015

Activity	Responsible party	Planned start date	Planned completion date	Deliverable(s)	Deliverable due date
analysis				packages	
Data validation	ARCADIS	13 June 2015	13 July 2015	Validation summary report	13 July 2015
Final report	ARCADIS	14 July 2015	30 August 2015	Final report	30 August 2015

Analysis Tasks

- Soil and sediment samples will be processed, prepared and analyzed by:
  - i. TestAmerica Burlington for volatile organic compounds (VOCs) by SOM01.2, semivolatile organic compounds (SVOCs) by SOM01.2, polynuclear aromatic hydrocarbons (PAHs) by SIM by SOM01.2, polychlorinated biphenyls (PCBs) Aroclors by SOM01.2, pesticides by SOM01.2, metals by ISM01.3, mercury by ISM01.3, cyanide by ISM01.3, total organic carbon (TOC) by Lloyd Kahn, and pH by SW-846 9045C.
  - ii. TestAmerica West Sacramento for polychlorinated biphenyl (PCB) congeners by EPA 1668A, and dioxins and furans by EPA 1613B.
- Surface water and groundwater samples will be processed, prepared and analyzed by:
  - i. TestAmerica Burlington for VOCs by SOM01.2, SVOCs by SOM01.2, PAHs by SIM by SOM01.2, PCB Aroclors by SOM01.2, pesticides by SOM01.2, metals by ISM01.3, mercury by ISM01.3, low level mercury by EPA 1631E, cyanide by ISM01.3, TOC by EPA SW846 9060, and pH by SW-846 9045C.
  - ii. TestAmerica West Sacramento for polychlorinated biphenyl (PCB) congeners by EPA 1668A, and dioxins and furans by EPA 1613B.

Quality Control Tasks

The samples will be collected and processed, and waste will be disposed of as documented in the field Standard Operating Procedures (SOPs). The quality assurance (QA) samples are described in Worksheet #20.

Secondary Data

See Worksheet #13.

Data Management Tasks

The purpose of data management is to confirm that the necessary data are accurate and readily accessible to meet the analytical and reporting objectives of the project. The field investigations will include a significant number of samples that require a structured, comprehensive and efficient program for management of data.

The data management program established for the project includes field documentation and sample QA/quality control (QC) procedures, methods for tracking and managing the data, and a system for filing all site-related information. More specifically, data management procedures will be employed to efficiently process the information collected, such that the data are readily accessible and accurate. These procedures are described in detail in the following section.

The data management plan has five elements: 1) sample designation system, 2) field activities, 3) sample tracking and management, 4) data management system, and 5) document control and inventory.

Sample Designation System

A concise and easily understandable sample designation system is an important part of project sampling activities. It provides a unique sample number that will facilitate both sample tracking and easy resampling of select locations to evaluate data gaps, if necessary. The sample designation system to be employed during the sampling activities will be consistent, yet flexible enough to accommodate unforeseen sampling events or conditions. A combination of letters and numbers will be used to yield a unique sample number for each field sample collected, as outlined below.

Sample Codes

Each sample will be identified by a unique identification number in the logbook, sampling log, and chain-of-custody (COC) record using an alphanumeric code. Field samples will be linked to geographic location via location codes. All field samples will be identified using the following convention in the order presented below:

The alphanumeric sample designation code prefix will indicate the sampling method and/or sample matrix, subarea from which the sample was collected, and a numeric code corresponding to the location number. The sample depth interval, in feet, will follow the location number, and provide unique identification for that sample. Location numbering will be designated using the following codes:

- Soil Sample – "SS"
- Surface-Water Sample – "SW"
- Sediment Sample – "SD"

- Groundwater Sample – "TW" if from a temporary monitoring well, or "MW" if from a permanent monitoring well
- Pore-Water Sample – "PW"
- Trip Blank Sample – "TB"
- Field Duplicate Sample – "DUP"
- Equipment Blank Sample – "EB"
- Matrix Spike and Matrix Spike Duplicate – "MS" and MSD"

The location code, consisting of a two to five digit designation, will follow the sample type code. For subsurface soil samples, the designation will also consist of the sample depth in feet. For example, a subsurface soil sample collected from a depth of 2 to 4 ft from SB02 would be designated SS-SB02 (2-4). For groundwater, surface-water, and pore-water samples, the sample code will also include a six-digit number indicating the month, day, and year the sample was obtained. For example, a groundwater sample collected from temporary monitoring well TW-2 on October 30, 2014 will be designated GW-TW-2(103014).

QA/QC samples will be designated by a three-letter code followed by the six-digit sample collection date. For field and equipment blanks, a two-letter sample type code will precede the blank designation to indicate which medium the blank was intended to represent. For example, a field blank collected on October 30, 2014 during surface soil samples collection would be designated SS-FB1-103014. The sampling point associations for field duplicates must be recorded in the field log.

Sample identification and labeling procedures may be modified as needed to supplement specific investigation objectives and any deviations identified in site-specific work plans.

Field Activities

Field activities require consistent documentation and accurate record keeping. During site activities, standardized procedures will be used for documentation of field activities, data security and QA. These procedures are described in further detail in the following subsections.

Field Documentation

Complete and accurate record keeping is a critical component of the field investigation activities. When interpreting analytical results and identifying data trends, investigators realize that field notes are an important part of the review and validation process. To confirm that the field investigation is thoroughly documented, several different information records, each with its own specific reporting requirements, will be maintained, including:

- field logs
- chain-of-custody (COC) forms
- instrument calibration records

Each of these types of field documentation is described below.

Field Logs

Personnel performing the field activities will keep field logs that detail observations and measurements made during the site work. Data will be recorded directly into site-dedicated, bound notebooks, with each entry dated and signed. To determine, at a future date, that notebook pages are not missing, each page will be sequentially numbered. Erroneous entries will be corrected by crossing out the original entry, initialing it and then documenting the proper information. In addition, certain media sample locations will be surveyed to accurately record their locations. The survey crew will use its own field logs and will supply the sampling location coordinates to the Database Administrator.

Chain-of-Custody Forms

COC forms are used to document and track sample possession from time of collection to the time of disposal. A COC form will accompany each field sample collected, and one copy of the form will be filed in the field office. Field personnel will be briefed on the proper use of the COC procedure.

Instrument Calibration Records

As part of data QA procedures, field monitoring and detection equipment will be routinely calibrated. Instrument calibration confirms that equipment used is of the proper type, range, accuracy and precision to provide data compatible with the specified requirements and desired results. Calibration procedures for the various types of field instrumentation are described in Worksheet 22. To demonstrate that established calibration procedures have been followed, calibration records will be prepared and maintained to include, as appropriate, the following:

- calibration date and time
- type and identification number of equipment
- calibration frequency and acceptable tolerances
- identification of individual(s) performing calibration
- reference standards used
- calibration data
- information on calibration success or failure

The calibration record will serve as a written account of monitoring or detection equipment QA. Erratic behavior or failures of field equipment will be subsequently recorded in the calibration log.

Data Security

Measures will be taken during the field investigation to confirm that samples and records are not lost, damaged or altered. When not in use, field notebooks will be stored at the field office or locked in the field vehicle. Access to these files will be limited to the field personnel who use them.

Sample Management and Tracking

A record of all field documentation will be maintained to confirm the validity of data used in the site analysis. To effectively execute such documentation, specific sample tracking and data management procedures will be used throughout the sampling program.

Sample tracking will begin with the completion of COC forms. The completed COC forms will be faxed to the ARCADIS Project Manager or their designee Copies of all completed COC forms will be maintained in the project file. The laboratory will verify receipt of the samples electronically (via e-mail) on the following day.

When analytical data are received from the laboratory, the Project QA Manager or designee will review the incoming analytical data packages against the information on the COCs to confirm that the correct analyses were performed for each sample and that results for all samples

submitted for analysis were received. Any discrepancies noted will be promptly followed up by the Project QA Manager or designee.

Data Management System

In addition to the sample tracking system, a data management system will be implemented. The central focus of the data management system will be the development of a personal computer-based project database. The project database, to be maintained by the Project Database Manager, will combine pertinent geographical, field and analytical data. Information that will be used to populate the database will be derived from three primary sources: surveying of sampling locations, field observations and analytical results. Each of these sources is discussed in the following sections.

Computer Hardware

The database will be constructed on personal computer work stations connected through a network server. The network will provide access to various hardware peripherals, such as laser printers, backup storage devices, image scanners and modems. Computer hardware will be upgraded to industrial and corporate standards, as necessary, in the future.

Computer Software

The individual electronic data deliverables (EDDs), supplied by the laboratory in either an ASCII comma separated value (CSV) format or in a Microsoft® Excel worksheet, will be loaded into the appropriate database table via a custom-designed user interface Visual Basic program. Any analytical data that cannot be provided by the laboratory in electronic format will be entered manually. After entry into the database, the EDD data will be compared to the field information previously entered into the database to confirm that all requested analytical data have been received.

Survey Information

In general, each location sampled as part of the work plan will be surveyed to confirm accurate documentation of sample locations for mapping and GIS purposes (if appropriate), to facilitate resampling of select sample locations during future monitoring programs, if needed, and for any potential remediation activities. Field books associated with the surveying activities will be stored as a record of the project activities. The collection and reporting of locational data must include the GPS accuracy.

Field Observations

An important part of the information that will ultimately reside in the data management system for use during the project will originate in the observations that are recorded in the field.

Following each sampling event, a status memorandum may be prepared by the field personnel who performed the sampling activities. The purpose of the status memo is to summarize and provide a record of the sampling event. Topics to be discussed include the locations sampled, blind duplicate and MS/MSD sample identification numbers, personnel involved in the activity, and any other noteworthy events or observations that occurred.

Tables are typically attached to the memorandum and are used to summarize measurements that were recorded in the field books. It is anticipated that these tables will be developed using a personal computer spreadsheet program to reduce possible transcription error and to facilitate the transfer of information to the data management system.

All pertinent field data will be manually entered into the appropriate database tables from the COC forms and field notebooks.

Analytical Results

Analytical results will be provided by the laboratory in a digital (pdf) or a hard copy format. The data packages will be examined to confirm that the correct analyses were performed for each sample submitted and that all of the analyses requested on the COC form were performed. If discrepancies are noted, the Project QA Manager will be notified and will promptly follow up with the laboratory to resolve any issues.

Each data package will be validated in accordance with procedures outlined in Worksheet #37. Data that do not meet the specified standards will be flagged pending resolution of the issue. The flag will not be removed from the data until the issue associated with the sample results is resolved. Although flags may remain for certain data, the use of the data may not necessarily be restricted.

Following completion of the data validation, the digital files will be used to populate the appropriate database tables. This format specifies one data record for each constituent for each sample analyzed. Specific fields include:

- sample identification number
- date sampled
- date analyzed
- parameter name
- analytical result

- units
- detection limit
- qualifier(s)

The individual EDDs, supplied by the laboratory in a Microsoft Excel worksheet, will be loaded into the appropriate database table. If dilutions or re-analyses are included in the EDD, the laboratory must designate which set of results are considered reportable. Any analytical data that cannot be provided by the laboratory in electronic format will be entered manually. After entry into the database, the EDD data will be compared to the field information previously entered into the database to confirm that all requested analytical data have been received.

Data Analysis and Reporting

The database management system will have several functions to facilitate the review and analysis of project data. Data entry screens will be developed to assist in the keypunching of field observations. Routines will also be developed to permit the user to scan analytical data from a given site for a given medium. Several output functions that have been developed by ARCADIS will be appropriately modified for use in the data management system.

A valuable function of the data management system will be the generation of tables of analytical results from the project database. The capability of the data management system to directly produce tables reduces the redundant manual entry of analytical results during report preparation and precludes transcription errors that may occur otherwise. This data management system function has the ability to process the data and generate tables. Tables of analytical data will be produced as part of data interpretation, data reporting, and generation of the Final Report.

For certain comparisons, PCB Aroclors may be summed to obtain a total PCB concentration for each sample location. Undetected Aroclors will be considered to be zero during this summation.

Some sample locations will be submitted for analysis of PCB congeners. These methods may have congeners that co-elute. The co-elution scheme for these analyses will be as described in the laboratory SOP. In the instance where co-eluting congener values may be reported multiple times, the result was included only once in the sum.

Another function of the data management system will be to create digital files of analytical results and qualifiers suitable for transfer to mapping/ presentation software. A function has been created by ARCADIS that creates a digital file consisting of sample location number, state plane coordinates, sampling date and detected constituents, and associated concentrations and analytical qualifiers. The file is then transferred to an AutoCAD work station, where another program has been developed to plot a location's analytical data in a "box" format at the sample location

(represented by the state plane coordinates). This routine greatly reduces the redundant keypunching of analytical results and facilitates the efficient production of interpretative and presentation graphics.

The data management system also has the capability of producing a digital file of select parameters that exists in one or more of the databases. This type of custom function is accomplished on an interactive basis and is best used for transferring select information into a number of analysis tools, such as statistical or graphing programs.

Documentation and Records

Field Documentation. Field personnel will provide comprehensive documentation covering all aspects of field sampling, field analysis and sample COC. This documentation constitutes a record that allows reconstruction of all field events to aid in the data review and interpretation process. All documents, records and information relating to the performance of the field work will be retained in the project file.

The various forms of documentation to be maintained throughout the action include:

- *Daily Production Documentation*. A field notebook consisting of a waterproof, bound notebook that will contain a record of all activities performed at the site.

- *Sampling Information*. Sampling locations, physical observations and weather conditions (as appropriate) will be described in the field notes.

- *Sample COC*. COC forms will provide the record of responsibility for sample collection, transport and submittal to the laboratory. COC forms will be filled out at each sampling site, at a group of sampling sites or at the end of each day of sampling by ARCADIS' field personnel designated to be responsible for sample custody. If the samples are relinquished by the designated sampling person to other sampling or field personnel, the COC form will be signed and dated by the appropriate personnel to document the sample transfer. The original COC form will accompany the samples to the laboratory, and copies will be forwarded to the project files.

  Persons will have custody of samples when the samples are in their physical possession, in their view after being in their possession, or in their physical possession and secured so they cannot be tampered with. In addition, when samples are secured in a restricted area accessible only to authorized personnel, they will be deemed to be in the custody of such authorized personnel.

- *Field Equipment, Calibration and Maintenance Logs*. To document the calibration and maintenance of field instrumentation, calibration

and maintenance logs will be maintained for each piece of field equipment that is not factory-calibrated.

Laboratory Project Files. The laboratory will establish a file for pertinent data. The file will include correspondence, faxed information, phone logs and COC forms. The laboratory will retain project files and data packages for a period to be determined by the Settling Parties.

Laboratory Logbooks. Workbooks, bench sheets, instrument logbooks and instrument printouts will be used to trace the history of samples through the analytical process and to document important aspects of the work, including the associated QCs. As such, logbooks, bench sheets, instrument logs and instrument printouts will be part of the permanent record of the laboratory. Each page or entry will be dated and initialed by the analyst at the time of entry. Errors in entry will be crossed out in indelible ink with one stroke, corrected without the use of white-out or by obliterating or writing directly over the erroneous entry, and initialed and dated by the individual making the correction. Pages of logbooks that are not used will be completed by lining out unused portions. Information regarding the sample, analytical procedures performed and results of the testing will be recorded on laboratory forms or personal notebook pages by the analyst. These notes will be dated and will also identify the analyst, instrument used and instrument conditions. Laboratory notebooks will be periodically reviewed by the laboratory group leaders for accuracy, completeness and compliance with this QAPP. All entries and calculations will be verified by the laboratory group leader. If all entries on the pages are correct, the laboratory group leader will initial and date the pages. Corrective action will be taken for incorrect entries before the laboratory group leader signs.

Computer and Hard Copy Storage. All electronic files and deliverables and hard copy data packages (or electronic copies) will be retained for a period to be determined by the Settling Parties.

Field Data Reporting. Information collected in the field through visual observation, manual measurement and/or field instrumentation will be recorded in field notebooks or data sheets and/or on forms. Such data will be reviewed by the ARCADIS Project Manager or their designee for adherence to the Work Plan and for consistency. Concerns identified as a result of this review will be discussed with the field personnel, corrected if possible and (as necessary) incorporated into the data evaluation process. If applicable, field data forms and calculations will be processed and included in appendices to the appropriate reports (when generated). The original field logs documents and data reductions will be kept in the project file at the ARCADIS office in Cranbury, New Jersey.

Laboratory Data Reporting. Data reports for all parameters will include, at a minimum, the following items:

Narrative: Summary of activities that took place during sample analysis, including the following information:

- laboratory name and address
- date of sample receipt

- cross reference of laboratory identification number to contractor sample identification
- analytical methods used
- deviations from specified protocol
- corrective actions taken

Included with the narrative will be any sample handling documents, including field and internal COC forms, air bills, and shipping tags.

Analytical Results: These will be reported according to analysis type and include the following information, as applicable:

- sample identification (ID)
- laboratory ID
- date of collection
- date of receipt
- date of extraction
- date of analysis
- method detection and reporting limits

Sample results on the report forms will be corrected for dilutions. Sediment and soil data will be reported on a dry weight basis. Unless otherwise specified, all results will be reported uncorrected for blank contamination.

The analyses performed will be reported as Contract Laboratory Program (CLP)-equivalent Level 4 data package which will include supporting documentation. This additional documentation will include, but not be limited to, raw data required to recalculate any result, including instrument printouts and quantitation reports. The report also will include standards used in calibration and calculation of analytical results; sample extraction, digestion and other preparation logs; standard preparation logs; instrument run logs; and moisture content calculations.

Data reporting levels are as follows:

- **Level 2 — Modified Reporting**: Modified reporting is used for analyses that are performed following standard USEPA-approved methods and QA/QC protocols. Based on the intended data use, modified reporting may require some supporting documentation, but not full CLP or CLP-type reporting.

- **Level 4 — Full Reporting**: Full CLP or CLP-type reporting is used for those analyses that, based on the intended data use, require full documentation.

Assessment/Audit Tasks

Performance and systems audits will be completed in the field and laboratory during the data gap investigations, as described below and in Worksheets #31 and #32.

1. ***Field Audits***. The following field performance and systems audits will be completed during this project.
   The ARCADIS Project Manager or their designee will monitor field performance. Field performance audit summaries will contain an evaluation of field activities to verify that the activities are performed according to established procedures as described in field SOPs. Field performance audits may be performed by the ARCADIS Project Manager (or her designee). The auditor(s) will review field reports and communicate concerns to the ARCADIS Project Manager and/or Field Task Manager, as appropriate.

   The number and frequency of field performance audits conducted will be determined independently by the Field Task Manager. The ARCADIS Project Manager will administer field performance audits at a frequency of approximately one per month during field activities. The observations made during field performance audits and any recommended changes/deviations to the field procedures will be recorded and documented.

   In addition, the Project QA Manager will review the rinse and trip blank data to identify potential deficiencies in field sampling and cleaning procedures. In addition, systems audits comparing scheduled QA/QC activities from this QAPP with actual QA/QC activities completed will be performed. The Field Task Manager and Project QA Manager will periodically confirm that work is being performed consistent with this QAPP.

2. **Laboratory Audits**

   Internal laboratory audits are conducted periodically by the Laboratory QA Manager. As part of the audit, the overall performance of the laboratory staff is evaluated and compared to the performance criteria outlined in the laboratory QA manual and SOPs. Results of the

audits are summarized and issued to each department supervisor, Laboratory Manager and Laboratory Director. A systems audit of each laboratory is also performed by the Project QA Manager to determine whether the procedures implemented by each laboratory comply with the QA manual and SOPs.

As a participant in state and federal certification programs, the laboratory is audited by representatives of the regulatory agency issuing certification, in addition to the laboratory's internal audits. Audits are usually conducted annually and focus on laboratory conformance to the specific program protocols for which the laboratory is seeking certification. The auditor reviews sample handling and tracking documentation, analytical methodologies, analytical supportive documentation and final reports. The audit findings are formally documented and submitted to the laboratory for corrective action, if necessary.

ARCADIS reserves the right to conduct an on-site audit of the laboratory prior to the start of analyses for the project. Additional audits may be performed during the project, as deemed necessary.

3. Corrective Action

Corrective actions are required when field or analytical data are not within the objectives specified in this QAPP. Corrective actions include procedures to promptly investigate, document, evaluate and correct data collection and/or analytical procedures. Field and laboratory corrective action procedures for the actions are described below.

a. Field Procedures

If, during field work, a condition is noted by the field crew that would have an adverse effect on data quality, corrective action will be taken so as not to repeat this condition. Condition identification, cause and corrective action implemented by the Field Task Manager or a designee will be documented on a Corrective Action Form and reported to the appropriate ARCADIS Project QA Manager and Project Manager.

Examples of situations that would require corrective actions are provided below:

- protocols as defined by the QAPP and/or field SOPs have not been followed
- equipment is not in proper working order or is not properly calibrated
- QC requirements have not been met

- issues resulting from performance or systems audits have not been resolved

Project personnel will continuously monitor ongoing work performance as part of daily responsibilities.

b. Laboratory Procedures

In the laboratory, when a condition is noted to have an adverse effect on data quality, corrective action will be taken so as not to repeat this condition. Condition identification, cause and corrective action taken will be documented and reported to the Project Manager and Project QA Manager.

Corrective action may be initiated, at a minimum, under the following conditions:

- protocols as defined by this QAPP have not been followed
- predetermined data acceptance standards are not obtained
- equipment is not in proper working order or calibrated
- sample and test results are not completely traceable
- QC requirements have not been met
- issues resulting from performance or systems audits have not been resolved

Laboratory personnel will continuously monitor ongoing work performance as part of daily responsibilities. Corrective action will be initiated at the point where the problem has been identified. At whatever level this occurs (analyst, supervisor, data review, or quality control), it will be brought to the attention of the Laboratory QA Manager and, ultimately, the Laboratory Director. Final approval of any action deemed necessary is subject to the approval of the Laboratory Director.

Any corrective action deemed necessary based on system or performance audits, the analytical results of split samples, or the results of data review will be implemented. The corrective action may include sample re-extraction, re-preparation, re-analysis, cleanup, dilution, matrix modification or other activities.

Data Review Tasks

See Worksheets #36 and #37.

QAPP Worksheet #15: Project Action Limits and Laboratory-Specific Detection/Quantitation Limits

Project action limits and laboratory-specific detection/quantitation limits are provided in Table 1 (attached).

QAPP Worksheet #17: Sampling Design and Rationale

Physical boundaries for the area under study

- Figure 1 depicts the boundaries of the landfill and surface debris area based on observations during test pit activities. Eastern and southern portions of the landfill are located within the GSNWR.

Time period being represented by the collected data

- Sampling will occur in two phases, beginning in October 2014 and ending in May 2015. Data can be compared to the previous sampling event to constrain annual and seasonal variations. All data will represent current conditions.

Description of the sampling area

- The sampling areas were selected to address specific data gaps in the previous investigation.
- They include soil near the southern perimeter of the landfill, groundwater across the landfill and adjacent areas, surface water and sediment in ponds both on and near the landfill, and pore water in wetlands on the west side of the landfill.

Sample locations

Sample locations are shown on Figures 2a and 2b.

Soil samples (20 samples, with 20 additional samples contingent on the results)

a. Basis for the number and placement of samples: Soil sampling will be conducted in a step-out manner. Soil samples will be collected in two lines: an inner line approximately 25 feet from the edge of the landfill, and an outer line approximately 50 feet from the edge of the landfill. The inner samples will be analyzed for the specific constituents that exceeded SRSs in the initial sample on the landfill. If the results of these analyses exceed the SRSs, samples from the outer line will be analyzed for those specific constituents. If the results from the outer line also exceed the SRSs, additional sampling may be needed to complete delineation.

b. How sample positions will be located: Sample locations were selected in consultation with USEPA. They will be located using site landmarks (e.g, monitoring wells or other permanent features) and global positioning system (GPS).

c. If a soil sample cannot be collected then the location may be moved to another location within 10 feet of the proposed location.

Groundwater samples (9 samples total) from temporary monitoring wells

a. Basis for the number and placement of samples: Temporary wells were placed upgradient and downgradient of well MW-3 and MW-10 to help identify potential sources of VOCs and to help delineate their downgradient extent.

b. How sample positions will be located: Sample locations were selected in consultation with USEPA. They will be located using site landmarks (e.g, monitoring wells or other permanent features) and GPS.

c. If a sample cannot be collected where planned, the temporary wells may be relocated or may be replaced with surface water samples.

Groundwater samples (31 samples total) from permanent monitoring wells

a. Basis for the number and placement of samples: The locations of wells include 17 historical permanent wells and 7 new wells. All 24 wells will be sampled once. The 7 new wells will be sampled a second time, resulting in a total of 31 samples.

b. How sample positions will be located: Sample locations were selected in consultation with USEPA. Locations for the new permanent wells will be selected in consultation with USEPA based on the results of soil samples and temporary monitoring wells.

c. If a sample cannot be collected (e.g., the well is dry) then the field staff will return later during the sampling event to check the conditions and collect the sample if possible.

Pore-water samples (2 samples total)

a. Basis for the number and placement of samples: Pore-water sample locations were selected to delineate potential migration of VOCs in groundwater from the area of monitoring well MW-10 to the southwest.

b. How sample positions will be located: Sample locations were selected in consultation with USEPA. They will be located using site landmarks (e.g, monitoring wells or other permanent features) and GPS.

c. If a sample cannot be collected where planned, the locations may be relocated within 10 feet of the proposed location.

Surface-water samples (11 samples total)

a. Basis for the number and placement of samples: Surface-water samples will be collected from surface water bodies on the landfill that were not sampled during the previous investigations.

b. How sample positions will be located: Sample locations were selected in consultation with USEPA. They will be located using site landmarks (e.g, monitoring wells or other permanent features) and GPS.

c. If a sample cannot be collected where planned, the location may be adjusted. Some of the water bodies where sampling is proposed are small and have not been directly observed during previous activities. They may be ephemeral or smaller than shown in Figures 2a and 2b. In such cases, the samples may be collected elsewhere or eliminated.

Sediment samples (11 samples total)

a. Basis for the number and placement of samples: Sediment samples will be collected from surface water bodies on the landfill that were not sampled during the previous investigations.

b. How sample positions will be located: Sample locations were selected in consultation with USEPA. They will be located using site landmarks (e.g, monitoring wells or other permanent features) and GPS.

c. If a sample cannot be collected where planned, the location may be adjusted. Some of the water bodies where sampling is proposed are small and have not been directly observed during previous activities. They may be ephemeral or smaller than shown in Figures 2a and 2b. In such cases, the samples may be collected elsewhere or eliminated.

QAPP Worksheet #18: Sampling Locations and Methods

Sample ID	Matrix	Depth (ft bgs)	Type	Analyte/Analytical Group	Sampling SOP	Comments
SS-125	Soil	0.0-1.0	Macrocore	PCBs (as Aroclors)	SOP 5	
SS-126	Soil	0.0-1.0	Macrocore	PCBs (as Aroclors)	SOP 5	Contingent sample
SS-127	Soil	0.0-1.0	Macrocore	SVOCs, SVOCs SIM, PCBs (as Aroclors), PCB (as Congeners), Dioxins, Furans, TAL Metals & Cyanide	SOP 5	
SS-128	Soil	0.0-1.0	Macrocore	SVOCs, SVOCs SIM, PCBs (as Aroclors), PCB (as Congeners), Dioxins, Furans, TAL Metals & Cyanide	SOP 5	Contingent sample
SS-129	Soil	0.0-1.0	Macrocore	SVOCs, SVOCs SIM, PCBs (as Aroclors), PCB (as Congeners), Dioxins, Furans, TAL Metals & Cyanide	SOP 5	
SS-130	Soil	0.0-1.0	Macrocore	SVOCs, SVOCs SIM, PCBs (as Aroclors), PCB (as Congeners), Dioxins, Furans, TAL Metals & Cyanide	SOP 5	Contingent sample
SS-131	Soil	0.0-1.0	Macrocore	PCBs (as Aroclors)	SOP 5	

Sample ID	Matrix	Depth (ft bgs)	Type	Analyte/Analytical Group	Sampling SOP	Comments
SS-132	Soil	0.0-1.0	Macrocore	PCBs (as Aroclors)	SOP 5	Contingent sample
SS-133	Soil	0.0-1.0	Macrocore	SVOCs, SVOCs SIM, TAL Metals & Cyanide	SOP 5	
SS-134	Soil	0.0-1.0	Macrocore	SVOCs, SVOCs SIM, TAL Metals & Cyanide	SOP 5	Contingent sample
SS-135	Soil	0.0-1.0	Macrocore	PCBs (as Aroclors), TAL Metals & Cyanide	SOP 5	
SS-136	Soil	0.0-1.0	Macrocore	PCBs (as Aroclors), TAL Metals & Cyanide	SOP 5	Contingent sample
SS-137	Soil	0.0-1.0	Macrocore	PCBs (as Aroclors), TAL Metals & Cyanide, PCBs (as Congeners), Dioxins, Furans	SOP 5	
SS-138	Soil	0.0-1.0	Macrocore	PCBs (as Aroclors), TAL Metals & Cyanide, PCBs (as Congeners), Dioxins, Furans	SOP 5	Contingent sample
SS-139	Soil	0.0-1.0	Macrocore	PCBs (as Aroclors), TAL Metals & Cyanide, PCBs (as Congeners), Dioxins, Furans	SOP 5	
SS-140	Soil	0.0-1.0	Macrocore	PCBs (as Aroclors), TAL Metals & Cyanide, PCBs (as Congeners), Dioxins, Furans	SOP 5	Contingent sample

Sample ID	Matrix	Depth (ft bgs)	Type	Analyte/Analytical Group	Sampling SOP	Comments
SS-141	Soil	0.0-1.0	Macrocore	PCBs (as Aroclors), TAL Metals & Cyanide	SOP 5	
SS-142	Soil	0.0-1.0	Macrocore	PCBs (as Aroclors), TAL Metals & Cyanide	SOP 5	Contingent sample
SS-143	Soil	0.0-1.0	Macrocore	TAL Metals & Cyanide	SOP 5	
SS-144	Soil	0.0-1.0	Macrocore	TAL Metals & Cyanide	SOP 5	Contingent sample
SS-145	Soil	0.0-1.0	Macrocore	SVOCs	SOP 5	
SS-146	Soil	0.0-1.0	Macrocore	SVOCs	SOP 5	Contingent sample
SS-147	Soil	0.0-1.0	Macrocore	SVOCs, PCBs (as Aroclors), Pesticides, TAL Metals & Cyanide	SOP 5	
SS-148	Soil	0.0-1.0	Macrocore	SVOCs, PCBs (as Aroclors), Pesticides, TAL Metals & Cyanide	SOP 5	Contingent sample
SS-149	Soil	0.0-1.0	Macrocore	SVOCs, PCBs (as Aroclors), TAL Metals & Cyanide	SOP 5	
SS-150	Soil	0.0-1.0	Macrocore	SVOCs, PCBs (as Aroclors), TAL Metals & Cyanide	SOP 5	Contingent sample
SS-151	Soil	0.0-1.0	Macrocore	SVOCs	SOP 5	

Sample ID	Matrix	Depth (ft bgs)	Type	Analyte/Analytical Group	Sampling SOP	Comments
SS-152	Soil	0.0-1.0	Macrocore	SVOCs	SOP 5	Contingent sample
SS-153	Soil	0.0-1.0	Macrocore	SVOCs	SOP 5	
SS-154	Soil	0.0-1.0	Macrocore	SVOCs	SOP 5	Contingent sample
SS-155	Soil	0.0-1.0	Macrocore	PCBs (as Aroclors), TAL Metals & Cyanide	SOP 5	
SS-156	Soil	0.0-1.0	Macrocore	PCBs (as Aroclors), TAL Metals & Cyanide	SOP 5	Contingent sample
SS-157	Soil	0.0-1.0	Macrocore	PCBs (as Aroclors), TAL Metals & Cyanide	SOP 5	
SS-158	Soil	0.0-1.0	Macrocore	PCBs (as Aroclors), TAL Metals & Cyanide	SOP 5	Contingent sample
SS-159	Soil	0.0-1.0	Macrocore	Full TCL/TAL, SVOCs SIM, PCBs (as Congeners), Dioxins, Furans	SOP 5	

Sample ID	Matrix	Depth (ft bgs)	Type	Analyte/Analytical Group	Sampling SOP	Comments
SS-160	Soil	0.0-1.0	Macrocore	Full TCL/TAL, SVOCs SIM, PCBs (as Congeners), Dioxins, Furans	SOP 5	Contingent sample
SS-161	Soil	0.0-1.0	Macrocore	Full TCL/TAL, SVOCs SIM, PCBs (as Congeners), Dioxins, Furans	SOP 5	
SS-162	Soil	0.0-1.0	Macrocore	Full TCL/TAL, SVOCs SIM, PCBs (as Congeners), Dioxins, Furans	SOP 5	Contingent sample
SS-163	Soil	0.0-1.0	Macrocore	Full TCL/TAL, SVOCs SIM, PCBs (as Congeners), Dioxins, Furans	SOP 5	
SS-164	Soil	0.0-1.0	Macrocore	Full TCL/TAL, SVOCs SIM, PCBs (as Congeners), Dioxins, Furans	SOP 5	Contingent sample
MW-1	Groundwater	TBD	Low flow	VOCs, TAL Metals & Cyanide (filtered & unfiltered)	SOP 7	Existing well
MW-2	Groundwater	TBD	Low flow	VOCs, TAL Metals & Cyanide (filtered & unfiltered)	SOP 7	Existing well
MW-3	Groundwater	TBD	Low flow	VOCs, SVOCs, SVOCs SIM, Pesticides, TAL	SOP 7	Existing well

Sample ID	Matrix	Depth (ft bgs)	Type	Analyte/Analytical Group	Sampling SOP	Comments
				Metals & Cyanide (filtered & unfiltered)		
MW-4	Groundwater	TBD	Low flow	VOCs, TAL Metals & Cyanide (filtered & unfiltered)	SOP 7	Existing well
MW-5	Groundwater	TBD	Low flow	VOCs, TAL Metals & Cyanide (filtered & unfiltered)	SOP 7	Existing well
MW-6	Groundwater	TBD	Low flow	VOCs, TAL Metals & Cyanide (filtered & unfiltered)	SOP 7	Existing well
MW-7	Groundwater	TBD	Low flow	VOCs, SVOCs, SVOCs SIM, TAL Metals & Cyanide (filtered & unfiltered)	SOP 7	Existing well
MW-8	Groundwater	TBD	Low flow	VOCs, TAL Metals & Cyanide (filtered & unfiltered)	SOP 7	Existing well
MW-9	Groundwater	TBD	Low flow	VOCs, TAL Metals & Cyanide (filtered & unfiltered)	SOP 7	Existing well

Sample ID	Matrix	Depth (ft bgs)	Type	Analyte/Analytical Group	Sampling SOP	Comments
MW-10	Groundwater	TBD	Low flow	VOCs, TAL Metals & Cyanide (filtered & unfiltered)	SOP 7	Existing well
MW-11	Groundwater	TBD	Low flow	VOCs, TAL Metals & Cyanide (filtered & unfiltered)	SOP 7	Proposed new well
MW-12	Groundwater	TBD	Low flow	VOCs, TAL Metals & Cyanide (filtered & unfiltered)	SOP 7	Proposed new well
MW-13	Groundwater	TBD	Low flow	VOCs, TAL Metals & Cyanide (filtered & unfiltered)	SOP 7	Proposed new well
MW-14	Groundwater	TBD	Low flow	VOCs, TAL Metals & Cyanide (filtered & unfiltered)	SOP 7	Proposed new well
MW-15	Groundwater	TBD	Low flow	VOCs, TAL Metals & Cyanide (filtered & unfiltered)	SOP 7	Proposed new well
MW-16	Groundwater	TBD	Low flow	VOCs, TAL Metals & Cyanide (filtered & unfiltered)	SOP 7	Proposed new well
MW-17	Groundwater	TBD	Low flow	VOCs, TAL Metals & Cyanide (filtered & unfiltered)	SOP 7	Proposed new well
X-1	Groundwater	TBD	Low flow	VOCs, TAL Metals & Cyanide (filtered &	SOP 7	Existing well

Sample ID	Matrix	Depth (ft bgs)	Type	Analyte/Analytical Group	Sampling SOP	Comments
				unfiltered)		
X-2	Groundwater	TBD	Low flow	VOCs, TAL Metals & Cyanide (filtered & unfiltered)	SOP 7	Existing well
X-3	Groundwater	TBD	Low flow	VOCs, TAL Metals & Cyanide (filtered & unfiltered)	SOP 7	Existing well
X-4	Groundwater	TBD	Low flow	VOCs, TAL Metals & Cyanide (filtered & unfiltered)	SOP 7	Existing well
X-5	Groundwater	TBD	Low flow	Full TCL/TAL, SVOCs SIM, TAL Metals & Cyanide (filtered)	SOP 7	Existing well
X-6	Groundwater	TBD	Low flow	VOCs, TAL Metals & Cyanide (filtered & unfiltered)	SOP 7	Existing well
X-7	Groundwater	TBD	Low flow	Full TCL/TAL, SVOCs SIM, TAL Metals & Cyanide (filtered)	SOP 7	Existing well

Sample ID	Matrix	Depth (ft bgs)	Type	Analyte/Analytical Group	Sampling SOP	Comments
TWP-1	Groundwater	TBD	Macrocore	VOCs, TAL Metals & Cyanide (filtered & unfiltered)	SOP 2	Temporary well
TWP-2	Groundwater	TBD	Macrocore	VOCs, TAL Metals & Cyanide (filtered & unfiltered)	SOP 2	Temporary well
TWP-3	Groundwater	TBD	Macrocore	VOCs, TAL Metals & Cyanide (filtered & unfiltered)	SOP 2	Temporary well
TWP-4	Groundwater	TBD	Macrocore	VOCs, TAL Metals & Cyanide (filtered & unfiltered)	SOP 2	Temporary well
TWP-5	Groundwater	TBD	Macrocore	VOCs, TAL Metals & Cyanide (filtered & unfiltered)	SOP 2	Temporary well
TWP-6	Groundwater	TBD	Macrocore	VOCs, TAL Metals & Cyanide (filtered & unfiltered)	SOP 2	Temporary well
TWP-7	Groundwater	TBD	Macrocore	VOCs, TAL Metals & Cyanide (filtered & unfiltered)	SOP 2	Temporary well
TWP-8	Groundwater	TBD	Macrocore	VOCs, TAL Metals & Cyanide (filtered & unfiltered)	SOP 2	Temporary well
TWP-9	Groundwater	TBD	Macrocore	VOCs, TAL Metals & Cyanide (filtered &	SOP 2	Temporary well

Sample ID	Matrix	Depth (ft bgs)	Type	Analyte/Analytical Group	Sampling SOP	Comments
				unfiltered)		
PWS -1	Pore Water	TBD	PDB	VOCs	SOP 20	Passive Sampler
PWS-2	Pore Water	TBD	PDB	VOCs	SOP 20	Passive Sampler
SW-34	Surface Water	TBD	Bailer/direct dip	SVOCs SIM, Full TCL/TAL, TAL Metals & Cyanide (filtered), LL Hg, Hardness, pH, TOC	SOP 8	Teflon-lined bailer
SW-35	Surface Water	TBD	Bailer/direct dip	Full TCL/TAL, SVOCs SIM, TAL Metals & Cyanide (filtered), LL Hg, Hardness, pH, TOC	SOP 8	Teflon-lined bailer
SW-36	Surface Water	TBD	Bailer/direct dip	Full TCL/TAL, SVOCs SIM, TAL Metals & Cyanide (filtered), LL Hg, Hardness, pH, TOC	SOP 8	Teflon-lined bailer

Sample ID	Matrix	Depth (ft bgs)	Type	Analyte/Analytical Group	Sampling SOP	Comments
SW-37	Surface Water	TBD	Bailer/direct dip	Full TCL/TAL, SVOCs SIM, TAL Metals & Cyanide (filtered), LL Hg, Hardness, pH, TOC	SOP 8	Teflon-lined bailer
SW-38	Surface Water	TBD	Bailer/direct dip	Full TCL/TAL, SVOCs SIM, TAL Metals & Cyanide (filtered), LL Hg, Hardness, pH, TOC	SOP 8	Teflon-lined bailer
SW-39	Surface Water	TBD	Bailer/direct dip	Full TCL/TAL, SVOCs SIM, TAL Metals & Cyanide (filtered), LL Hg, Hardness, pH, TOC	SOP 8	Teflon-lined bailer
SW-40	Surface Water	TBD	Bailer/direct dip	Full TCL/TAL, SVOCs SIM, TAL Metals & Cyanide (filtered), LL Hg, Hardness, pH, TOC	SOP 8	Teflon-lined bailer
SW-41	Surface Water	TBD	Bailer/direct dip	Full TCL/TAL, SVOCs SIM, TAL Metals & Cyanide (filtered), LL Hg, Hardness, pH, TOC	SOP 8	Teflon-lined bailer

Sample ID	Matrix	Depth (ft bgs)	Type	Analyte/Analytical Group	Sampling SOP	Comments
SW-42	Surface Water	TBD	Bailer/direct dip	Full TCL/TAL, SVOCs SIM, TAL Metals & Cyanide (filtered), LL Hg, Hardness, pH, TOC	SOP 8	Teflon-lined bailer
SW-43	Surface Water	TBD	Bailer/direct dip	Full TCL/TAL, SVOCs SIM, TAL Metals & Cyanide (filtered), LL Hg, Hardness, pH, TOC	SOP 8	Teflon-lined bailer
SW-44	Surface Water	TBD	Bailer/direct dip	Full TCL/TAL, SVOCs SIM, TAL Metals & Cyanide (filtered), LL Hg, Hardness, pH, TOC	SOP 8	Teflon-lined bailer
SD-34	Sediment	TBD	Grab sample	Full TCL/TAL, SVOCs SIM, pH, TOC, Grain size	SOP 14	
SD-35	Sediment	TBD	Grab sample	Full TCL/TAL, SVOCs SIM, pH, TOC, Grain size	SOP 14	
SD-36	Sediment	TBD	Grab sample	Full TCL/TAL, SVOCs SIM, pH, TOC, Grain size	SOP 14	

Sample ID	Matrix	Depth (ft bgs)	Type	Analyte/Analytical Group	Sampling SOP	Comments
SD-37	Sediment	TBD	Grab sample	Full TCL/TAL, SVOCs SIM, pH, TOC, Grain size	SOP 14	
SD-38	Sediment	TBD	Grab sample	Full TCL/TAL, SVOCs SIM, pH, TOC, Grain size	SOP 14	
SD-39	Sediment	TBD	Grab sample	Full TCL/TAL, SVOCs SIM, pH, TOC, Grain size	SOP 14	
SD-40	Sediment	TBD	Grab sample	Full TCL/TAL, SVOCs SIM, pH, TOC, Grain size	SOP 14	
SD-41	Sediment	TBD	Grab sample	Full TCL/TAL, SVOCs SIM, pH, TOC, Grain size	SOP 14	
SD-42	Sediment	TBD	Grab sample	Full TCL/TAL, SVOCs SIM, pH, TOC, Grain size	SOP 14	
SD-43	Sediment	TBD	Grab sample	Full TCL/TAL, SVOCs SIM, pH, TOC, Grain size	SOP 14	
SD-44	Sediment	TBD	Grab sample	Full TCL/TAL, SVOCs SIM, pH, TOC, Grain size	SOP 14	

QAPP Worksheet #19 & 30: Sample Containers, Preservation, and Hold Times

Laboratory: TestAmerica, Inc. 30 Community Dr, Suite 11 S. Burlington, VT 05403 Attn: Sample Receiving

List any required accreditations/certifications: Active CLP Routine Analytical Services Laboratory with contract number EPW11036 (Organic Multi - SOM01.2) and EPW09044 (Inorganic - ISM01.3); NJ NELAP VT972 Expires 06/30/15

Back-up Laboratory: Not identified

Sample Delivery Method: FedEx Overnight

Analyte/ Analyte Group	Matrix	Method/ SOP	Container (number, size & type per sample)	Preservation	Preparation Holding Time	Analytical Holding Time	Data Package Turnaround
Pesticides	Soil/sediment	SOM01.2/TAB -2	1x 4-ounce (oz) glass jar with Teflon®-lined lid	Cool to <6°C	10 days from verified time of sample receipt (VTSR)	40 days from extraction date	4 weeks
PCB Aroclors	Soil/sediment	SOM01.2/TAB -1	1x 4-oz glass jar with Teflon®-lined lid	Cool to <6°C	10 days from VTSR	40 days from extraction date	4 weeks
PCB Congeners	Soil/sediment	EPA 1668/TAWS-1	1x 4-oz glass jar with Teflon®-lined lid	Cool to <6°C	1 year from VTSR	40 days from extraction date	4 weeks
Metals/Cyanide	Soil/sediment	ISM01.3/TAB-5, TAB-6, TAB-7	1x 4-oz glass jar with Teflon®-lined lid	Cool to <6°C	NA	180 days VTSR – ICP, 26 days VTSR – Hg, 12 days VTSR	4 weeks

Analyte/ Analyte Group	Matrix	Method/ SOP	Container (number, size & type per sample)	Preservation	Preparation Holding Time	Analytical Holding Time	Data Package Turnaround
						- CN	
VOCs	Soil/Sediment	SOM01.2/TAB -4	2 x 40-milliliter (mL) vial 5ml DI water & 1 40mL vial 5mL MeOH	Cool to <6°C	NA	10 day VTSR (vials must be frozen with 48 hours)	4 weeks
SVOCs/ SVOC SIM	Soil/Sediment	SOM01.2/ SOM01.2-SIM/TAB-3	1 – 4oz amber glass	Cool to <6°C	10 days from VTSR	40 days from extraction date	4 weeks
Dioxins, furans	Soil/sediment	EPA 1613/TAWS-14	1x 8-ounce glass jar with Teflon®-lined lid or stainless steel liner	Cool to <6°C	1 year from VTSR	40 days	4 weeks
TOC	Soil/sediment	Lloyd Kahn/TAB-9	1x 2-oz glass jar with Teflon®-lined lid	Cool to <6°C	NA	28 days from collection date	4 weeks
VOCs	Water	SOM01.2/TAB -11	3 x 40-mL vials	No headspace; HCl to pH <2; Cool to <6°C	NA	10 days VTSR	4 weeks

Analyte/ Analyte Group	Matrix	Method/ SOP	Container (number, size & type per sample)	Preservation	Preparation Holding Time	Analytical Holding Time	Data Package Turnaround
SVOCs/ SVOC SIM	Water	SOM01.2/SOM01.2-SIM/TAB-3	2 x 1-liter (L) amber bottles	Cool to <6°C	5 days VTSR	40 days from extraction date	4 weeks
TAL Metals	Water	ISM01.3/TAB-5, TAB-6	1 x 500-mL high density polyethylene (HDPE)	HNO_3 to pH <2; Cool to <6°C	NA	180 days VTSR – ICP, 26 days VTSR - Hg	4 weeks
Cyanide	Water	ISM01.3/TAB-7	1 x 250-mL HDPE	NaOH to pH >12; Cool to <6°C	NA	12 days VTSR	4 weeks
Pesticides	Water	SOM01.2/TAB-2	2 x 1-L amber bottles	Cool to <6°C	5 days VTSR	40 days from extraction date	4 weeks
PCB Aroclors	Water	SOM01.2/TAB-1	2 x 1-L amber bottles	Cool to <6°C	5 days VTSR	40 days from extraction date	4 weeks
Mercury LL	Water	1631E/TANC-12	4 – 40 mL Vials	Cool to <6°C	Unpreserved sample – preserve or analyze within 48 hours of collection; Preserved sample – 28 days	28 days from collection	4 weeks

QAPP Worksheet #20: Field QC Summary

Matrix	Analyte/Analytical Group	Method/ SOP	Field Samples	Field Duplicates	Matrix Spikes	Matrix Spike Duplicates	Equipment Blanks	Trip Blanks	Total # analyses
Soil	SVOCs	SOM01.2/TAB-3	22	1	1	1	1	0	26
Soil	SVOCs SIM	SOM01.2-SIM/TAB-3	12	1	1	1	1	0	16
Soil	Pesticides	SOM01.2/TAB-3	8	1	1	1	1	0	12
Soil	PCBs Aroclors	SOM01.2/TAB-1	30	2	1	1	1	0	35
Soil	TAL Metals	ISM01.3/TAB-5, TAB-6	30	2	1	1	1	0	35
Soil	PCB Congeners	EPA 1668/TAWS-1	14	1	1	1	1	0	18
Soil	Dioxins and Furans	EPA 1613/TAWS-2	14	1	1	1	1	0	18
Groundwater (temporary wells)	VOCs	SOM01.2/TAB-11	9	1	1	1	1	2	15
Groundwater (temporary wells)	TAL Metals and Cyanide (unfiltered)	ISM01.3/TAB-5, TAB-6, TAB-7	9	1	1	1	1	0	13
Groundwater (temporary wells)	TAL Metals and Cyanide (filtered)	ISM01.3/TAB-5, TAB-6, TAB-7	9	1	1	1	1	0	13
Groundwater (permanent wells)	VOCs	SOM01.2/TAB-11	31	3[a]	2[b]	2[b]	7	5	50
Groundwater (permanent	SVOCs	SOM01.2/TAB-3	4	1[a]	1[b]	1[b]	1	0	8

Matrix	Analyte/Analytical Group	Method/ SOP	Field Samples	Field Duplicates	Matrix Spikes	Matrix Spike Duplicates	Equipment Blanks	Trip Blanks	Total # analyses
wells)									
Groundwater (permanent wells)	SVOCs SIM	SOM01.2-SIM/TAB-3	4	1[a]	1[b]	1[b]	1	0	8
Groundwater (permanent wells)	Pesticides	SOM01.2/TAB-2	3	1[a]	1[b]	1[b]	1	0	7
Groundwater (permanent wells)	PCB Aroclors	SOM01.2/TAB-1	2	1[a]	1[b]	1[b]	1	0	6
Groundwater (permanent wells)	TAL Metals and Cyanide (unfiltered)	ISM01.3/TAB-5, TAB-6, TAB-7	31	3[a]	2[b]	2[b]	7	0	45
Groundwater (permanent wells)	TAL Metals and Cyanide (filtered)	ISM01.3/TAB-5, TAB-6, TAB-7	31	3[a]	2[b]	2[b]	7	0	45
Pore Water	VOCs	SOM01.2/TAB-11	2	1	0[c]	0[c]	0[c]	1	4
Surface Water	VOCs	SOM01.2/TAB-11	11	1	1	1	1	2	17
Surface Water	SVOCs	SOM01.2/TAB-3	11	1	1	1	1	0	15
Surface Water	SVOCs SIM	SOM01.2-SIM/TAB-3	11	1	1	1	1	0	15
Surface Water	Pesticides	SOM01.2-TAB-2	11	1	1	1	1	0	15
Surface Water	PCBs Aroclors	SOM01.2/TAB-1	11	1	1	1	1	0	15
Surface	TAL Metals and	ISM01.3/TAB-5,	11	1	1	1	1	0	15

Matrix	Analyte/Analytical Group	Method/ SOP	Field Samples	Field Duplicates	Matrix Spikes	Matrix Spike Duplicates	Equipment Blanks	Trip Blanks	Total # analyses
Water	Cyanide (unfiltered)	TAB-6, TAB-7							
Surface Water	TAL Metals and Cyanide (Filtered)	ISM01.3/TAB-5, TAB-6, TAB-7	11	1	1	1	1	0	15
Surface Water	Low-Level Mercury	EPA 1631E/TANC-12	11	1	1	1	1	0	15
Surface Water	Hardness	Calculation	11	0	0	0	0	0	11
Sediment	VOCs	SOM01.2/TAB-4	11	1	1	1	1	2	17
Sediment	SVOCs	SOM01.2/TAB-3	11	1	1	1	1	0	15
Sediment	SVOCs SIM	SOM01.2-SIM/TAB-3	11	1	1	1	1	0	15
Sediment	Pesticides	SOM01.2-TAB-2	11	1	1	1	1	0	15
Sediment	PCBs Aroclors	SOM01.2/TAB-1	11	1	1	1	1	0	15
Sediment	TAL Metals and Cyanide	ISM01.3/TAB-5, TAB-6, TAB-7	11	1	1	1	1	0	15
Sediment	pH, TOC, grain size	Lloyd Kahn/TAB-9	11	0	0	0	0	0	11

[a] Two field duplicate samples will be collected during the first groundwater event and one field duplicate sample will be collected during the second groundwater event.

[b] One matrix spike and matrix spike duplicate sample will be collected during the first groundwater event and one matrix spike and matrix spike duplicate sample will be collected during the second groundwater event.

[c] No matrix spike or matrix spike duplicate samples were collected as the sample matrix consists of deionized water. No equipment blank is required because the samples are transferred directly from the pore water Permeable Diffusion Bag to the sample bottles.

QAPP Worksheet #21: Field SOPs

SOP # or reference	Title, Revision, Date, and URL (if available)	Originating Organization	SOP option or Equipment Type (if SOP provides different options)	Modified for Project? Y/N	Comments
SOP 1	Water Level Measurement	ARCADIS		N	
SOP 2	Standard GW Sampling for Monitoring Wells	ARCADIS		N	
SOP 3	Monitoring Well Installation	ARCADIS		N	
SOP 4	Monitoring Well Development	ARCADIS		N	
SOP 5	Drilling Procedures for Collecting and Screening of Soil Samples	ARCADIS		N	
SOP 6	Soil Description	ARCADIS		N	
SOP 7	Low-Flow Groundwater Purging and Sampling Procedures for Monitoring Wells	ARCADIS		N	
SOP 8	Surface Water Sampling	ARCADIS		N	
SOP 9	Chain-of-Custody, Handling, Packing and Shipping	ARCADIS		N	
SOP 10	Investigation-Derived Waste Handling and Storage	ARCADIS		N	
SOP 11	Field Equipment Decontamination	ARCADIS		N	

SOP # or reference	Title, Revision, Date, and URL (if available)	Originating Organization	SOP option or Equipment Type (if SOP provides different options)	Modified for Project? Y/N	Comments
SOP 12	Measuring Basic Water Quality Parameters In-situ	ARCADIS		N	
SOP 13	Sediment Core Collection	ARCADIS		N	
SOP 14	Sediment Sampling	ARCADIS		N	
SOP 15	Extraction/Preservation of Soil/ Sediment Samples for VOCs	ARCADIS		N	
SOP 16	Compositing or Homogenizing Samples	ARCADIS		N	
SOP 17	Surface and Subsurface Soil Sampling Using Manual Methods	ARCADIS		N	
SOP 18	Soil Drilling and Sample Collection	ARCADIS		N	
SOP 19	Field Log Book Entries	ARCADIS		N	
SOP 20	Pore Water Sampling	ARCADIS		N	

QAPP Worksheet #22: Field Equipment Calibration, Maintenance, Testing, and Inspection

Field Equipment	Activity	SOP Reference	Title or position of responsible person	Frequency	Acceptance Criteria	Corrective Action
Water Quality meter	Check all membranes and sensors, cable and check battery charge	SOP 12	Field Staff	See SOP 12	See SOP 12	See SOP 12
Photoionization Detector (PID)	Calibrate	SOP 5	Field Staff	See SOP 5	See SOP 5	See SOP 5
Water-Level Meter	Check battery	SOP 1	Field Staff	See SOP 1	See SOP 1	See SOP 1
GPS	As required by manufacturer specification	NA	Field Staff	NA	NA	NA

QAPP Worksheet #23: Analytical SOP's

SOP #	Title, Date, and URL (if available)	Definitive or Screening Data	Matrix/Analytical Group	SOP Option or Equipment Type	Modified for Project? Y/N
F-4	FSP – Water Column Sampling Procedures	Definitive	Temperature, pH, turbidity, conductivity, dissolved oxygen (DO)	Water quality meter	N
F-3	FSP – Sediment Sampling Procedures	Screening	Water surface elevation	Water level meter	N
F-3	FSP – Sediment Sampling Procedures	Screening	Core characterization	Unified Soil Classification System (USCS) or United States Department of Agriculture (USDA) soil classification system	N
Agriculture (USDA) soil classificati on systemNT AWS-1	'PCB Analysis by HRGC/HRMS',WS-ID-0013, Rev 4.4, 5/07/14 and 'PCB Preparation for Analysis by HRGC/HRMS' WS-IDP-0013, Rev 3.0, 9/12/14	Definitive	PCB Congeners in Water, Soil and Sediment	High Resolution Gas Chromatography/ High Resolution/Mass Spectrometry (HRGC/HRMS)	N
TAWS-2	'Analysis of Tetra- through Octa Chlorinated Dioxins and Furans by Isotope Dilution HRGC/HRMS by Method 1613B', WS-ID-0007, Rev 3.7, 2/07/14 and 'Preparation of Samples for Tetra- through Octa Chlorinated Dioxins and Furans by Isotope Dilution HRGC/HRMS by Method 1613B' WS-IDP-0007, Rev 1.9, 4/11/2014	Definitive	Dioxins and Furans in Water, Soil and Sediment	HRGC/HRMS	N
TAB-1	'Determination of Aroclors by GC/ECD (CLP SOW SOM01.2)', BR-GC-010, Rev 1, 6/02/08 and 'Extraction and Cleanup Procedure for the Determination of Aroclors	Definitive	PCB Aroclors in Water, Soil and Sediment	Gas Chromatography/ Electron Capture Dectector (GC/ECD)	N

	(CLP SOW SOM01.2)', BR-EX-013, Rev 2, 2/21/14				
TAB-2	'Determination of Pesticides by GC/ECD (CLP SOW SOM01.2)', BR-GC-011, Rev 1, 6/02/08 and 'Sample Preparation and Cleanup Procedure for Pesticides (CLP SOW SOM01.2)', BR-EX-014, Rev 2, 02/24/14	Definitive	Pesticides in Water, Soil and Sediment	GC/ECD	N
TAB-3	'SVOCs by GC/MS and GC/MS SIM (CLP SOM01.2)', BR-MS-006, Rev 1, 11/10/10 and 'Sample Preparation and Cleanup Procedure for SVOCs (CLP SOW SOM01.2)',BR-EX-015 Rev 2, 02/24/14	Definitive	SVOCs in Water, Soil and Sediment	Gas Chromatography/ Mass Spectrometry (GC/MS)	N
TAB-4	'Analytical Method for Low/Medium Volatiles (CLP SOW SOM01.2)', BR-MV-009 Rev 0, 1/01/08	Definitive	VOCs in Water, Soil and Sediment	GC/MS	N
TAB-5	'Determination of Trace Metals by ICP-OES (CLP SOW ISM01.3)', BR-ME-019, Rev 1, 10/29/12	Definitive	Metals, except mercury in Water, Soil and Sediment	Inductively coupled atomic plasma-optical emission spectroscopy (ICP-OES)	N
TAB-6	'Determination of Mercury by Cold Vapor Analysis (CLP SOW ISM01.2)', BR-ME-018, Rev 0, 08/06/10	Definitive	Mercury in Water, Soil, and Sediment	Mercury autoanalyzer	N
TAB-7	'Determination of Total Cyanide'(CLP SOW ISM01.3), BR-WC-023, Rev 0, 08/06/10		Cyanide in Water, Soil, and Sediment		
TAB-9	'Total Organic Carbon in Soils & Sediments (Lloyd Kahn)', BR-WC-008, Rev 14, 03/18/14	Definitive	TOC	TOC analyzer	N
TAB-11	'Analytical Method for Trace Volatiles (CLP SOW SOM01.2)', BR-MV-010, Rev 0, 1/1/2008	Definitive	VOCs in Water	GC/MS	N
TANC-12	'Preparation and Analysis of Mercury in Aqueous and Solid Samples by Cold Vapor Atomic Fluorescence Method 1631E', NC-MT-001, Rev 6, 9/27/13	Definitive	Low level Mercury in Water	Cold Vapor Atomic Fluorescence Spectroscopy (CVAFS)	N

QAPP Worksheet #24: Analytical Instrument Calibration

Instrument	Calibration Procedure	Frequency	Acceptance Criteria	Corrective Action (CA)	Title/position responsible for CA	SOP Reference
GC/MS for VOCs by SOM01.2	Instrument performance check: Bromofluorobenzene (BFB)	Once at the beginning of each 12-hour period during which samples or standards are analyzed.	% Relative abundance, see SOM01.2 Exhibit D Low/Medium Volatiles Section 17 Table 1	Retune instrument.	TestAmerica Analyst	See TAB-4 and TAB-11
	Initial calibration (ICAL) – minimum of five concentrations	Prior to sample analysis, after instrument performance check acceptance criteria have been met.	Relative standard deviation (RSD) and RRF, see SOM01.2 Exhibit D Low/Medium Volatiles Section 17 Table 4	Inspect system, correct problem, rerun calibration and affected samples.		
	Continuing calibration verification (CCV) – opening	Prior to sample analysis and after instrument performance check and ICAL acceptance criteria and have been met.	Percent difference (%D) and RRF, see SOM01.2 Exhibit D Low/Medium Volatiles Section 17 Table 4	Inspect system, correct problem, rerun calibration and affected samples.		
	CCV – closing	After all samples and blanks have been analyzed, and before the	%D ±50% for all compounds and RRF ≥ 0.010 for all compounds.	Inspect system, correct problem, rerun calibration and affected samples.		

Instrument	Calibration Procedure	Frequency	Acceptance Criteria	Corrective Action (CA)	Title/position responsible for CA	SOP Reference
		end of the 12-hour time period. May be used as the opening CCV for a new 12-hour analytical sequence.				
GC/MS for SVOCs by SOM01.2 and SOM01.2 SIM (PAHs)	Instrument performance check: Decafluorotriphenylphosphine (DFTPP)	Once at the beginning of each 12-hour period during which samples or standards are analyzed.	% Relative abundance, see SOM01.2 Exhibit D Semivolatiles Section 17 Table 1	Retune instrument.	TestAmerica Analyst	See TAB-3
	Initial calibration (ICAL) – minimum of five concentrations	Prior to sample analysis, after instrument performance check acceptance criteria have been met.	Relative standard deviation (RSD) and RRF, see SOM01.2 Exhibit D Semivolatiles Section 17 Table 4	Inspect system, correct problem, rerun calibration and affected samples.		
	Continuing calibration verification (CCV) – opening	Prior to sample analysis and after instrument performance check and ICAL acceptance criteria and have been met.	Percent difference (%D) and RRF, see SOM01.2 Exhibit D Semivolatiles Section 17 Table 4	Inspect system, correct problem, rerun calibration and affected samples.		
	CCV - closing	After all samples and blanks have been analyzed, and before the end of the 12-hour time period. May be used as	%D ±50% for all compounds and RRF ≥ 0.010 for all compounds.	Inspect system, correct problem, rerun calibration and affected samples.		

Instrument	Calibration Procedure	Frequency	Acceptance Criteria	Corrective Action (CA)	Title/position responsible for CA	SOP Reference
		the opening CCV for a new 12-hour analytical sequence.				
HRGC/HRMS for EPA 1668 and 1613	Instrument performance check (tune).	Prior to initial and continuing calibration.	As per method.	Retune instrument.	TestAmerica Analyst	See TAWS-1 and TAWS-2
	Initial calibration — a minimum of five concentration levels for all compounds.	Prior to sample analysis; minimum of annually.	Each compound RRF RSD ≤ 35% for all compounds and RF RSD ≤20%.	Inspect system, correct problem, rerun calibration and affected samples if RSD > 50%.		
	Continuing calibration — before sample analysis; one midpoint standard.	Before sample analysis and every 12 hours.	Each compound RRF %D ≤ 35% and RF %D ≤20%.	Inspect system, correct problem, rerun calibration and affected samples if %D > 80%.		
GC/ECD for PCB Aroclors by SOM01.2	ICAL – minimum of five concentrations for Aroclors 1016 and 1260; single mid-point calibration for other Aroclors	Prior to sample analysis. If any Aroclors other than 1016 and 1260 are detected in a sample, a five-point initial calibration is required for the detected Aroclor.	RSD ≤ 20% for any Aroclor analyzed at a five-point calibration.	Inspect system, correct problem, rerun calibration and affected samples.	TestAmerica Analyst	See TAB-1
	CCV – opening; mid-point concentration for Aroclor 1016/1260 and any other Aroclor detected in a sample	At the beginning of the analytical sequence.	Retention time (RT) within the RT window established for the ICAL. %D within ±15.0%.	Inspect system, correct problem, rerun calibration and affected samples.		
	CCV – closing; mid-point concentration for Aroclor 1016/1260 and any other Aroclor detected in a sample	At the beginning of the analytical sequence.	RT within the RT window established for the ICAL. %D within ±50.0%.	Inspect system, correct problem, rerun calibration and affected samples.		
GC/ECD for Pesticides by SOM01.2	ICAL – single-component compounds – minimum of five concentrations	Prior to sample analysis.	Initial Calibration RSD ≤ 20% for compounds or linear $r^2 \geq 0.99$, except for	Inspect system, correct problem, and rerun calibration.	TestAmerica Analyst	See TAB-2

Instrument	Calibration Procedure	Frequency	Acceptance Criteria	Corrective Action (CA)	Title/position responsible for CA	SOP Reference
			alpha-BHC and delta-BHC must be ≤ 25.0%, %RSD of the two surrogates must be ≤ 30.0%.			
	ICAL – Toxaphene (multi-component compound) – minimum of five concentrations	Prior to sample analysis.	The %RSD of the CFs for each Toxaphene peak and surrogates must be ≤ 30.0%	Inspect system, correct problem, and rerun calibration.		
	Opening CCV – before sample analysis; one midpoint standard. Toxaphene CCV analyzed if detected in sample.	Prior to sample analysis.	The %D for compounds and surrogates in the PEM ± 25.0%; %D in the calibration verification standard (CS) ± 20.0%	Inspect system, correct problem, and rerun calibration.		
	Closing CCV	After 12 hours.	Same as Opening CCV	Inspect system, correct problem, rerun calibration and affected samples.		
ICP-AES for ISM01.3	ICAL: blank and at least five standards; one standard shall be at or below	Daily, prior to sample analysis.	Correlation coefficient r ≥ 0.995.	Terminate analysis, correct problem, and re-verify calibration	TestAmerica Analyst	See TAB-5
	Initial calibration verification (ICV)	Following each instrument calibration.	Within ±10% of the true value.	Terminate analysis, correct problem, and re-verify calibration.		
	CCV	Every 2 hours of analytical run, and at the beginning and end of each run.	Within ±10% of the true value.	Terminate analysis, correct problem, re-verify calibration, and reanalyze all samples analyzed since the last compliant CCV.		
	Initial and continuing calibration blank (ICB/CCB)	ICB: Following each instrument calibration, immediately after the ICV. CCB: Every 2 hours of a run,	< CRQL	Terminate analysis, correct problem, recalibrate instrument, re-verify calibration, and reanalyze all samples analyzed since the lab compliant CCB.		

Instrument	Calibration Procedure	Frequency	Acceptance Criteria	Corrective Action (CA)	Title/position responsible for CA	SOP Reference
		and at the beginning and end of each run. Performed immediately after the CCV.				
CVAA for ISM01.3 (mercury)	ICAL: blank and at least five standards; one standard shall be at or below	Daily or each time instrument is set up, after ICV or CCV failures, and after major instrument adjustment.	Correlation coefficient r ≥ 0.995.	Terminate analysis, correct problem, and re-verify calibration.	TestAmerica Analyst	See TAB-6
	Initial calibration verification (ICV)	Following each instrument calibration.	Within ±15% of the true value.	Terminate analysis, correct problem, and re-verify calibration.		
	CCV	Every hour of a run, and at the beginning and end of each run.	Within ±15% of the true value.	Terminate analysis, correct problem, re-verify calibration, and reanalyze all samples analyzed since the last compliant CCV.		
	Initial and continuing calibration blank (ICB/CCB)	ICB: Following each instrument calibration, immediately after the ICV. CCB: Every 2 hours of a run, and at the beginning and end of each run. Performed immediately after the CCV.	< CRQL	Terminate analysis, correct problem, recalibrate instrument, re-verify calibration, and reanalyze all samples analyzed since the lab compliant CCB.		
CVAFS for Low Level Mercury Analysis by EPA 1631E	Initial calibration (ICAL) per manufacturer's instructions, with a minimum of six standards and three calibration blanks.	Daily initial calibration prior to sample analysis	Calibration factors must have < 15% RSD, and the low standard must calculate back to +	Evaluate standard and instrument response. Repeat ICAL.	TestAmerica Analyst	See TANC-12

Instrument	Calibration Procedure	Frequency	Acceptance Criteria	Corrective Action (CA)	Title/position responsible for CA	SOP Reference
			25% of the true value.			
	Second-source ICV (QCS)	Beginning of every analytical sequence.	80% - 120% Recovery	Terminate analysis, correct the problem, recalibrate, or re-prep with calibration curve.		
	Continuing calibration verification (CCV or OPR)	Following ICV/ICB, after every 10 samples and the end of the sequence	77% - 123% recovery	Evaluate standard and instrument response. If problem with instrument (autosampler failure, response poor, etc.) or standards, correct as appropriate, then repeat. If still fails, repeat initial calibration. Re-analyze all samples since the last successful calibration verification.		
	Calibration blank (ICB/CCB)	After ICAL, after CCV calibration, after every 10 samples, and at the end of the sequence	No target analytes ≥ RL in accordance with requirements	Terminate analysis, correct problem, recalibrate instrument, re-verify calibration, and reanalyze all samples analyzed since the lab compliant CCB.		
pH Meter	Initial calibration with two buffers that bracket pH of samples at room temperature.	Daily.	Slope reading after calibration should be between 94-102%.	If slope falls out of range of slope reading, troubleshoot and fix problem according to user's manual.	TestAmerica Analyst	See laboratory QAM
Analytical Balance	See laboratory Quality Assurance Manual (QAM)	Daily.	Not applicable	Inspect system, correct problem, rerun calibration and affected samples.	TestAmerica Analyst	See laboratory QAM

Note: the analytical laboratory, TestAmerica, has a SOP review cycle related to the CLP SOW methods. This review cycle only occurs as the EPA CLP SOW methods are updated and promulgated.

Worksheet #25: Analytical Instrument and Equipment Maintenance, Testing, and Inspection

Instrument /Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action (CA)	Title/ position responsible for CA	Reference
CVAFS	Check argon flow, pump tubing, drain, soda lime drying tube.	Sensitivity check	Instrument performance and sensitivity	Daily	CCV pass criteria	Troubleshoot and correct problem	TestAmerica Chemist	NC-MT-001
CVAFS	Check Hg lamp intensity	Sensitivity check	Instrument performance and sensitivity	Semi-annually	CCV pass criteria	Troubleshoot and correct problem	TestAmerica Chemist	NC-MT-001
CVAFS	Change Hg lamp, liquid/gas separator, Nafion dryer	General maintenance	Instrument performance and sensitivity	As Needed	CCV pass criteria	Troubleshoot and correct problem	TestAmerica Chemist	NC-MT-001
GC/MS	Clean Injection Port and Liner, Change Septa, Replace or clip Guard Column and or Analytical Column, and Fill		Check Injection Port and Liner, Check Septa, Check Guard Column and or Analytical Column, and Check	As required	Passing calibration	Perform maintenance, check standards, recalibrate	Laboratory Analyst	SOP BR-QAM

Instrument /Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action (CA)	Title/ position responsible for CA	Reference
	Autosampler rinse vials		Autosampler rinse vials					
GC	Replace Septa, Clean and replace Injection Port Liner, Replace or clip Guard Column Replace or clip Analytical Column Bake, Re-foil, Refurbish Detector		Instrument performance and sensitivity	As required	Passing calibration	Perform maintenance, check standards, recalibrate	Laboratory Analyst	SOP BR-QAM
ICP-AES	Replace Peristaltic Pump tubing, Clean Torch and Cones, Fill Rinse, Internal Standard, and Standards Vessels, Empty Waste Vessels		Check Peristaltic Pump tubing, Check Torch and Cones, Check Level of Rinse, Internal Standard, and Standards Vessels, Check	As required	Passing calibration	Perform maintenance, check standards, recalibrate	Laboratory Analyst	SOP BR-QAM

Instrument /Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action (CA)	Title/ position responsible for CA	Reference
			Waste Vessels					
CVAA	Lubricate Autosampler rods, Clean Autosampler Fill Rinse Vessel, Fill Stannous Chloride, and Empty Waste Vessel		Check Peristaltic Pump tubing, Check/ Rinse Vessel, Check Stannous Chloride, and Check Waste Vessel	As required	Passing calibration	Perform maintenance, check standards, recalibrate	Laboratory Analyst	SOP BR-QAM
GC/HRMS	Parameter Setup	Physical check	Physical check	Initially; prior to DCC	Correct Parameters	Reset if incorrect	TestAmerica Chemist	WS-ID-0007
GC/HRMS	Tune Check	Instrument Performance	Conformance to instrument tuning.	Initially; prior to DCC	Compliance to ion abundance criteria	Correct the problem and repeat tune check	TestAmerica Chemist	WS-ID-0007

Worksheet #26 & 27: Sample Handling, Custody, and Disposal

Worksheet #26 – Sample Handling System

Sample Collection, Packaging and Shipment
Sample Collection (Personnel/Organization): Field Personnel/ARCADIS
Sample Packaging (Personnel/Organization): Field Personnel/ARCADIS
Coordination of Shipment (Personnel/Organization): Field Personnel/ARCADIS
Type of Shipment/Carrier: pick-up at site by TestAmerica courier, or Federal Express to TestAmerica
Sample Receipt and Analysis
Sample Receipt (Personnel/Organization): Sample Custodian/TestAmerica
Sample Custody and Storage (Personnel/Organization): Sample Custodian/TestAmerica
Sample Preparation (Personnel/Organization): Lab Analysts/TestAmerica
Sample Determinative Analysis (Personnel/Organization): Lab Analysts/TestAmerica
Sample Archiving
Field Sample Storage: 30 days from submittal of laboratory final report
Sample Extract/Digestate Storage (number of days from extraction/digestion): 60 days
Sample Disposal
Personnel/Organization: Sample Custodian/TestAmerica
Number of Days from Analysis: 30-day minimum from submittal of laboratory final report

Worksheet #27 – Sample Custody Requirements

Sample Handling and Custody Requirements
At all times, field and laboratory personnel will be aware of the need to maintain all samples, whether in the field or in the laboratory, under strict chain-of-custody and in a manner to retain physical properties and chemical composition. This Worksheet details sample handling and custody requirements from collection to ultimate disposal.
Sample Handling
Sample packaging and shipment procedures are designed so that the samples will arrive at the laboratory, with the chain-of-custody, intact. Samples will be packaged for shipment as outlined below: • Securely affix the sample label to the container with clear packing tape. • Check the cap on the sample container to confirm that it is properly sealed. • Wrap the sample container cap with clear packing tape to prevent the label from becoming loose. • Complete the chain-of-custody form with the required sampling information and confirm that the recorded information matches the sample labels. **Note:** If the designated sampler relinquishes the samples to other sampling or field personnel for packing or other purposes, the sampler will complete the chain-of-custody prior to this transfer. The appropriate personnel will sign and date the chain-of-custody form to document the sample custody transfer. • Using duct tape, secure the outside drain plug at the bottom of the cooler. • Wrap sample containers in bubble wrap or other cushioning material. • Place 1 to 2 inches of cushioning material at the bottom of the cooler. • Place the sealed sample containers into the cooler. • Place ice in plastic bags and seal. Place loosely in the cooler. • Fill the remaining space in the cooler with cushioning material. • Place chain-of-custody forms in a plastic bag and seal. Tape the forms to the inside of the cooler lid. • Close the lid of the cooler, lock and secure with duct tape. • Wrap strapping tape around both ends of the cooler at least twice. • Mark the cooler on the outside with the shipping address and return address, affix “Fragile” labels and draw (or affix) arrows indicating “this side up.” Cover the labels with clear plastic tape. • Place a signed custody seal over the sample cooler lid.
Shipping Procedures
Samples will be packaged by field personnel and transported as low-concentration environmental samples. Samples will be hand delivered or delivered by an express carrier within 48 hours of the time of collection. Shipments will be accompanied by the chain-of-custody form identifying the contents. The original form will accompany the shipment; copies will be retained by the sampler for the sampling office records. If the

Worksheet #27 – Sample Custody Requirements

samples are sent by common carrier, a bill of lading will be used. Receipts or bills of lading will be retained as part of the permanent project documentation. Commercial carriers are not required to sign off on the chain-of-custody form as long as the forms are sealed inside the sample cooler and the custody seals remain intact.

Sample custody seals and packing materials for filled sample containers will be provided by the analytical laboratory. The filled, labeled and sealed containers will be placed in a cooler on ice and carefully packed to eliminate the possibility of container breakage.

Field Custody Procedures

The objective of field sample custody is to protect samples from tampering from the time of sample collection through time of transport to the analytical laboratory. Persons will have custody of samples when the samples are in their physical possession, in their view after being in their possession, or in their physical possession and secured so they cannot be tampered with. In addition, when samples are secured in a restricted area accessible only to authorized personnel, they will be deemed to be in the custody of such authorized personnel.

Field custody documentation consists of both field logbooks and field chain-of-custody forms.

Field logbooks will provide the means of recording the data collecting activities that are performed. As such, entries will be described in as much detail as possible so that persons going to the site could reconstruct a particular situation without reliance on memory.

Field logbooks will be bound field survey books or notebooks. Logbooks will be assigned to field personnel, but will be stored in a secure location when not in use. Each logbook will be identified by the project-specific document number. The title page of each logbook will contain the following:

- person to whom the logbook is assigned
- logbook number
- project name
- project start date
- end date

Entries into the logbook will contain a variety of information. At the beginning of each entry, the date, start time, weather conditions, names of all sampling team members present, level of personal protection being used, and signature of the person making the entry will be provided. The names of visitors to the site and field sampling or investigation team personnel, as well as the purpose of their visit, will also be recorded in the field logbook.

Measurements made and samples collected will be recorded. Entries will be made in ink, with no erasures. If an incorrect entry is made, the information will be crossed out with one strike mark. Whenever a sample is collected or a measurement is made, a detailed description of the location of the station will be recorded. The number of the photographs taken, if any, will also be noted. All equipment used to make

Worksheet #27 – Sample Custody Requirements

measurements will be identified, along with the date of calibration.

Samples will be collected following the sampling procedures documented in the Standard Operating Procedures in Appendix A and Worksheet #14. The equipment used to collect samples will be noted, along with the time of sampling, sample description, depth at which the sample was collected, volume and number of containers. Sample identification numbers will be assigned prior to sample collection. Field duplicate samples, which will receive an entirely separate sample identification number, will be noted under sample description.

Sample Labels

Sample labels will be affixed to sample bottles prior to delivery at the sampling site. The following information is required on each sample label:

- project name
- date collected
- time collected
- location
- name of sampler
- analysis to be performed
- preservative
- sample number

Chain-of-Custody Record

Completed chain-of-custody forms will be required for all samples to be analyzed. Chain-of-custody forms will be initiated by the sampling crew in the field. The chain-of-custody forms will contain the unique sample identification number, sample date and time, sample description, sample type, preservation (if any) and analyses required. The original chain-of-custody form will accompany the samples to the laboratory. Copies of the chain-of-custody will be made prior to shipment (or multiple copy forms will be used) for field documentation. The chain-of-custody forms will remain with the samples at all times. The samples and signed chain-of-custody forms will remain in the possession of the sampling crew until the samples are delivered to the express carrier (e.g., Federal Express), hand delivered to a mobile or permanent laboratory, or placed in secure storage.

Sample labels will be completed for each sample using waterproof ink. The labels will include the information listed in the previous section (Sample Labels). The completed sample labels will be affixed to each sample bottle and covered with clear tape.

Whenever samples are split with a government agency or other party, a separate chain-of-custody will be prepared for those samples and marked to identify the party with whom the samples are being split. The person relinquishing the samples to the facility or agency should request the representative's signature acknowledging sample receipt. If the representative is unavailable or refuses, note this in the "Received By" space.

Worksheet #27 – Sample Custody Requirements

Laboratory Custody Procedures
Upon sample receipt, laboratory personnel will be responsible for sample custody. The original field chain-of-custody form will accompany all samples requiring laboratory analysis. The laboratory will use chain-of-custody guidelines described in the United States Environmental Protection Agency guidance documents. Samples will be kept secured in the laboratory until all stages of analysis are complete. All laboratory personnel having samples in their custody will be responsible for documenting and maintaining sample integrity. Immediately upon sample receipt, the laboratory sample custodian will verify the integrity of the cooler seal, open the cooler, and compare the contents against the field chain-of-custody. If a sample container is missing, a sample container is received broken, the sample is in an inappropriate container, or the sample has not been preserved by appropriate means, ARCADIS will be notified. The laboratory sample custodian will be responsible for logging the samples in, assigning a unique laboratory identification number to each sample, labeling the sample bottle with the laboratory identification number, and moving the sample to an appropriate storage location to await analysis. The project name, field sample code, date sampled, date received, analysis required, storage location and date, and action for final disposition will be recorded in the laboratory tracking system. Relevant custody documentation will be placed in the project file.

QAPP Worksheet #28: Analytical Quality Control and Corrective Action

Quality Assurance Project Plan Worksheet #28-1 – Quality Control Samples (Semivolatile Organic Compounds in Water by SOM01.2 and SOM01.2-SIM)

Matrix	Water	**Analytical Method/ SOP Reference**	SOM01.2/SOM01.2-SIM/TAB-3	**No. of Sample Locations**	Numerous	
Analytical Group	SVOCs	**Sampler's Name**	NA			
Concentration Level	All	**Field Sampling Organization**	ARCADIS Sampling Personnel			
Sampling SOP	SOP 2, SOP 7, SOP 8, SOP 20	**Analytical Organization**	Test America			
Quality Control (QC) Sample	**Frequency/Number[1]**	**Method/SOP QC Acceptance Limits**	**Corrective Action**	**Person(s) Responsible for Corrective Action**	**Data Quality Indicator (DQI)**	**Measurement Performance Criteria**
Field duplicate	One per 10 field samples of similar matrix	RPD < 35%	Qualify data as needed.	Data validator	Precision – overall	RPD < 35%
DMC	Added to all samples and blanks	%R, see SOM01.2 – Exhibit D Semivolatiles Tables 6 (%R) 7 (associated target compounds), and 8 (associated target compounds – SIM)	Check calculations, sample preparation logs, DMC standard spiking solution, and instrument operation. Re-extract/reanalyze samples. Qualify data as needed.	Laboratory analyst and/or data validator	Accuracy/bias	%R, see SOM01.2 – Exhibit D Semivolatiles Tables 6 (%R) 7 (associated target compounds), and 8 (associated target compounds – SIM)
Method blanks	One per analytical batch	< CRQL	Investigate source of contamination and re-extract/reanalyze associated samples. Qualify data as needed.	Laboratory analyst and/or data validator	Accuracy/bias contamination	< CRQL

Quality Assurance Project Plan Worksheet #28-1 – Quality Control Samples (Semivolatile Organic Compounds in Water by SOM01.2 and SOM01.2-SIM)

Matrix	Water	**Analytical Method/ SOP Reference**	SOM01.2/SOM01.2-SIM/TAB-3	**No. of Sample Locations**	Numerous	
Analytical Group	SVOCs	**Sampler's Name**	NA			
Concentration Level	All	**Field Sampling Organization**	ARCADIS Sampling Personnel			
Sampling SOP	SOP 2, SOP 7, SOP 8, SOP 20	**Analytical Organization**	Test America			
Quality Control (QC) Sample	**Frequency/Number[1]**	**Method/SOP QC Acceptance Limits**	**Corrective Action**	**Person(s) Responsible for Corrective Action**	**Data Quality Indicator (DQI)**	**Measurement Performance Criteria**
Equipment blanks	One per 20 field samples	< CRQL	Qualify data as needed.	Data validator	Accuracy/bias contamination	< CRQL
Instrument check: DFTPP	One per calibration	%R, see SOM01.2 – Exhibit D Semivolatiles Table 1	Re-tune the instrument and reanalyze associated samples.	Laboratory analyst	Accuracy/bias	%R, see SOM01.2 – Exhibit D Semivolatiles Table 1
Internal standard	Added to all samples and blanks	Area response 50.0% to 200% and retention time (RT) ±30.0 seconds from associated 12-hour calibration standard, see SOM01.2 – Exhibit D Semivolatiles Table 2 (associated target compounds)	Check calculations, internal standard solutions, and instrument operation. Re-extract/reanalyze samples. Qualify data as needed.	Laboratory analyst and/or data validator	Precision	Area response 50.0% to 200% and retention time (RT) ±30.0 seconds from associated 12-hour calibration standard, see SOM01.2 – Exhibit D Semivolatiles Table 2 (associated target compounds)

Quality Assurance Project Plan Worksheet #28-1 – Quality Control Samples (Semivolatile Organic Compounds in Water by SOM01.2 and SOM01.2-SIM)

Matrix	Water	**Analytical Method/ SOP Reference**	SOM01.2/SOM01.2-SIM/TAB-3	**No. of Sample Locations**	Numerous	
Analytical Group	SVOCs	**Sampler's Name**	NA			
Concentration Level	All	**Field Sampling Organization**	ARCADIS Sampling Personnel			
Sampling SOP	SOP 2, SOP 7, SOP 8, SOP 20	**Analytical Organization**	Test America			
Quality Control (QC) Sample	**Frequency/Number[1]**	**Method/SOP QC Acceptance Limits**	**Corrective Action**	**Person(s) Responsible for Corrective Action**	**Data Quality Indicator (DQI)**	**Measurement Performance Criteria**
MS[2]	One per batch	%R, see SOM01.2 - Exhibit D Semivolatile Table 5	Re-extract/reanalyze samples. Qualify data as needed	Laboratory analyst and/or data validator	Accuracy/bias	%R, see SOM01.2 - Exhibit D Semivolatile Table 5
MSD[2]	One per batch	%R, see SOM01.2 - Exhibit D Semivolatile Table 5	Re-extract/reanalyze samples. Qualify data as needed	Laboratory analyst and/or data validator	Accuracy/bias	%R, see SOM01.2 - Exhibit D Semivolatile Table 5
MS/MSD[2]	One per batch	%R, see SOM01.2 - Exhibit D Semivolatile Table 5	Re-extract/reanalyze samples. Qualify data as needed	Laboratory analyst and/or data validator	Precision	%R, see SOM01.2 - Exhibit D Semivolatile Table 5

Note:
[1] An analytical batch is defined as no more than 20 analytical samples including field samples and field blanks.
[2] MS and MSD must be client-provided.

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Quality Assurance Project Plan Worksheet #28-2 – Quality Control Samples (Volatile Organic Compounds in Water by SOM01.2)

Matrix	Water	**Analytical Method/ SOP Reference**	SOM01.2/TAB-11	**No. of Sample Locations**	Numerous	
Analytical Group	VOCs	**Sampler's Name**	NA			
Concentration Level	All	**Field Sampling Organization**	ARCADIS Sampling Personnel			
Sampling SOP	SOP 2, SOP 7, SOP 8, SOP 20	**Analytical Organization**	Test America			
Quality Control (QC) Sample	**Frequency/Number[1]**	**Method/SOP QC Acceptance Limits**	**Corrective Action**	**Person(s) Responsible for Corrective Action**	**Data Quality Indicator (DQI)**	**Measurement Performance Criteria**
Field duplicate	One per 10 field samples of similar matrix	RPD < 35%	Qualify data as needed.	Data validator	Precision – overall	RPD < 35%
DMC	Added to all samples and blanks	%R, see SOM01.2 – Exhibit D Low/Medium Volatiles Tables 5 (%R) and 7 (associated target compounds)	Check calculations, sample preparation logs, DMC standard spiking solution, and instrument operation. Re-extract/reanalyze samples. Qualify data as needed.	Laboratory analyst and/or data validator	Accuracy/bias	%R, see SOM01.2 – Exhibit D Low/Medium Volatiles Tables 5 (%R) and 7 (associated target compounds)
Method blanks	One per analytical batch	< CRQL	Investigate source of contamination and re-extract/reanalyze associated samples. Qualify data as needed.	Laboratory analyst and/or data validator	Accuracy/bias contamination	< CRQL
Equipment blanks	One per 20 field samples	< CRQL	Qualify data as needed.	Data validator	Accuracy/bias contamination	< CRQL

Quality Assurance Project Plan Worksheet #28-2 – Quality Control Samples (Volatile Organic Compounds in Water by SOM01.2)

Matrix	Water	**Analytical Method/ SOP Reference**	SOM01.2/TAB-11	**No. of Sample Locations**	Numerous	
Analytical Group	VOCs	**Sampler's Name**	NA			
Concentration Level	All	**Field Sampling Organization**	ARCADIS Sampling Personnel			
Sampling SOP	SOP 2, SOP 7, SOP 8, SOP 20	**Analytical Organization**	Test America			
Quality Control (QC) Sample	**Frequency/Number[1]**	**Method/SOP QC Acceptance Limits**	**Corrective Action**	**Person(s) Responsible for Corrective Action**	**Data Quality Indicator (DQI)**	**Measurement Performance Criteria**
Instrument check: BFB	One per calibration	%R, see SOM01.2 – Exhibit D Low/Medium Volatiles Table 1	Re-tune the instrument and reanalyze associated samples.	Laboratory analyst	Accuracy/bias	%R, see SOM01.2 – Exhibit D Low/Medium Volatiles Table 1
Internal standard	Added to all samples and blanks	Area response 50.0% to 200% and retention time (RT) ±30.0 seconds from associated 12-hour calibration standard, see SOM01.2 – Exhibit D Low/Medium Volatiles Table 3 (associated target compounds)	Check calculations, internal standard solutions, and instrument operation. Re-extract/reanalyze samples. Qualify data as needed.	Laboratory analyst and/or data validator	Precision	Area response 50.0% to 200% and retention time (RT) ±30.0 seconds from associated 12-hour calibration standard, see SOM01.2 – Exhibit D Semivolatiles Table 2 (associated target compounds)
MS[2]	One per batch	%R, see SOM01.2 - Exhibit D Low/Medium Volatiles Table 6	Re-extract/reanalyze samples. Qualify data as needed	Laboratory analyst and/or data validator	Accuracy/bias	%R, see SOM01.2 - Exhibit D Low/Medium Volatiles Table 6

Quality Assurance Project Plan Worksheet #28-2 – Quality Control Samples (Volatile Organic Compounds in Water by SOM01.2)

Matrix	Water	**Analytical Method/ SOP Reference**	SOM01.2/TAB-11	**No. of Sample Locations**	Numerous	
Analytical Group	VOCs	**Sampler's Name**	NA			
Concentration Level	All	**Field Sampling Organization**	ARCADIS Sampling Personnel			
Sampling SOP	SOP 2, SOP 7, SOP 8, SOP 20	**Analytical Organization**	Test America			
Quality Control (QC) Sample	**Frequency/Number[1]**	**Method/SOP QC Acceptance Limits**	**Corrective Action**	**Person(s) Responsible for Corrective Action**	**Data Quality Indicator (DQI)**	**Measurement Performance Criteria**
MSD[2]	One per batch	%R, see SOM01.2 - Exhibit D Low/Medium Volatiles Table 6	Re-extract/reanalyze samples. Qualify data as needed	Laboratory analyst and/or data validator	Accuracy/bias	%R, see SOM01.2 - Exhibit D Low/Medium Volatiles Table 6
MS/MSD[2]	One per batch	%R, see SOM01.2 - Exhibit D Low/Medium Volatiles Table 6	Re-extract/reanalyze samples. Qualify data as needed	Laboratory analyst and/or data validator	Precision	%R, see SOM01.2 - Exhibit D Low/Medium Volatiles Table 6

Note:

[1] An analytical batch is defined as no more than 20 analytical samples including field samples and field blanks.

[2] MS and MSD must be client-provided.

Quality Assurance Project Plan Worksheet #28-3 – Quality Control Samples (Pesticides in Water by SOM01.2)

Matrix	Water	**Analytical Method/ SOP Reference**	SOM01.2/TAB-2	**No. of Sample Locations**	Numerous	
Analytical Group	Pesticides	**Sampler's Name**	NA			
Concentration Level	All	**Field Sampling Organization**	ARCADIS Sampling Personnel			
Sampling SOP	SOP 2, SOP 7, SOP 8, SOP 20	**Analytical Organization**	Test America			
QC Sample	**Frequency/Number[1]**	**Method/SOP QC Acceptance Limits[3]**	**Corrective Action**	**Person(s) Responsible for Corrective Action**	**DQI**	**Measurement Performance Criteria**
Field duplicate	One per 10 field samples of similar matrix	RPD < 35%	Qualify data as needed	Data validator	Precision – overall	RPD < 35%
Surrogate spikes	Added to all samples and blanks	%R: 30-150%	Check calculations, sample preparation logs, surrogate spiking solution, and instrument operation. Re-extract/reanalyze samples. Qualify data as needed.	Laboratory analyst and/or data validator	Accuracy/bias	%R: 30-150%
Method blanks	One per analytical batch	< CRQL	Investigate source of contamination and re-extract/reanalyze associated samples. Qualify data as needed.	Laboratory analyst and/or data validator	Accuracy/bias contamination	< CRQL
Equipment blanks	One per 20 field samples	< CRQL	Qualify data as needed	Data validator	Accuracy/bias contamination	< CRQL

Quality Assurance Project Plan Worksheet #28-3 – Quality Control Samples (Pesticides in Water by SOM01.2)

Matrix	Water	**Analytical Method/ SOP Reference**	SOM01.2/TAB-2	**No. of Sample Locations**	Numerous	
Analytical Group	Pesticides	**Sampler's Name**	NA			
Concentration Level	All	**Field Sampling Organization**	ARCADIS Sampling Personnel			
Sampling SOP	SOP 2, SOP 7, SOP 8, SOP 20	**Analytical Organization**	Test America			
QC Sample	**Frequency/Number[1]**	**Method/SOP QC Acceptance Limits[3]**	**Corrective Action**	**Person(s) Responsible for Corrective Action**	**DQI**	**Measurement Performance Criteria**
LCS	One per analytical batch	%R, see SOM01.2 - Exhibit D Pesticides Table 2	Re-extract/reanalyze associated samples. Qualify data as needed	Laboratory analyst and/or data validator	Accuracy/bias	%R, see SOM01.2 - Exhibit D Pesticides Table 2
MS[2]	One per analytical batch	%R, see SOM01.2 - Exhibit D Pesticides Table 3	Re-extract/reanalyze samples. Qualify data as needed	Laboratory analyst and/or data validator	Accuracy/bias	%R, see SOM01.2 - Exhibit D Pesticides Table 3
MSD[2]	One per analytical batch	%R, see SOM01.2 - Exhibit D Pesticides Table 3	Re-extract/reanalyze samples. Qualify data as needed	Laboratory analyst and/or data validator	Accuracy/bias	%R, see SOM01.2 - Exhibit D Pesticides Table 3
MS/MSD[2]	One per analytical batch	%R, see SOM01.2 - Exhibit D Pesticides Table 3	Re-extract/reanalyze samples. Qualify data as needed	Laboratory analyst and/or data validator	Precision	%R, see SOM01.2 - Exhibit D Pesticides Table 3

Note:
[1] An analytical batch is defined as no more than 20 analytical samples including field samples and field blanks.
[2] MS and MSD must be client-provided.

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Quality Assurance Project Plan Worksheet #28-4 – Quality Control Samples (PCBs in Water by SOM01.2)

Matrix	Water	**Analytical Method/ SOP Reference**	SOM01.2/TAB-1	**No. of Sample Locations**	Numerous	
Analytical Group	PCBs	**Sampler's Name**	NA			
Concentration Level	All	**Field Sampling Organization**	ARCADIS Sampling Personnel			
Sampling SOP	SOP 2, SOP 7, SOP 8, SOP 20	**Analytical Organization**	Test America			
QC Sample	**Frequency/Number[1]**	**Method/SOP QC Acceptance Limits[3]**	**Corrective Action**	**Person(s) Responsible for Corrective Action**	**DQI**	**Measurement Performance Criteria**
Field duplicate	One per 10 field samples of similar matrix	RPD < 35%	Qualify data as needed	Data validator	Precision – overall	RPD < 35%
Surrogate spikes	Added to all samples and blanks	%R: 30-150%	Check calculations, sample preparation logs, surrogate spiking solution, and instrument operation. Re-extract/reanalyze samples. Qualify data as needed.	Laboratory analyst and/or data validator	Accuracy/bias	%R: 30-150%
Method blanks	One per analytical batch	< CRQL	Investigate source of contamination and re-extract/reanalyze associated samples. Qualify data as needed.	Laboratory analyst and/or data validator	Accuracy/bias contamination	< CRQL
Equipment blanks	One per 20 field samples	< CRQL	Qualify data as needed	Data validator	Accuracy/bias contamination	< CRQL
LCS	One per analytical batch	%R, see SOM01.2 - Exhibit D Aroclors Table 2	Re-extract/reanalyze associated samples. Qualify data as needed	Laboratory analyst and/or data validator	Accuracy/bias	%R, see SOM01.2 - Exhibit D Aroclors Table 2
MS[2]	One per analytical batch	%R, see SOM01.2 - Exhibit D Aroclors Table 1	Re-extract/reanalyze samples. Qualify data as needed	Laboratory analyst and/or data validator	Accuracy/bias	%R, see SOM01.2 - Exhibit D Aroclors Table 1

Quality Assurance Project Plan Worksheet #28-4 – Quality Control Samples (PCBs in Water by SOM01.2)

Matrix	Water	**Analytical Method/ SOP Reference**	SOM01.2/TAB-1	**No. of Sample Locations**	Numerous	
Analytical Group	PCBs	**Sampler's Name**	NA			
Concentration Level	All	**Field Sampling Organization**	ARCADIS Sampling Personnel			
Sampling SOP	SOP 2, SOP 7, SOP 8, SOP 20	**Analytical Organization**	Test America			
QC Sample	**Frequency/Number[1]**	**Method/SOP QC Acceptance Limits[3]**	**Corrective Action**	**Person(s) Responsible for Corrective Action**	**DQI**	**Measurement Performance Criteria**
MSD[2]	One per analytical batch	%R, see SOM01.2 - Exhibit D Aroclors Table 1	Re-extract/reanalyze samples. Qualify data as needed	Laboratory analyst and/or data validator	Accuracy/bias	%R, see SOM01.2 - Exhibit D Aroclors Table 1
MS/MSD[2]	One per analytical batch	%R, see SOM01.2 - Exhibit D Aroclors Table 1	Re-extract/reanalyze samples. Qualify data as needed	Laboratory analyst and/or data validator	Precision	%R, see SOM01.2 - Exhibit D Aroclors Table 1

Note:
[1] An analytical batch is defined as no more than 20 analytical samples including field samples and field blanks.
[2] MS and MSD must be client-provided.

Quality Assurance Project Plan Worksheet #28-5 – Quality Control Samples (Metals. Mercury, and Cyanide in Water by ISM01.3)

Matrix	Water	**Analytical Method/ SOP Reference**	ISM01.3/TAB-5, TAB-6, TAB-7	**No. of Sample Locations**	Numerous	
Analytical Group	Metals, Mercury, and Cyanide	**Sampler's Name**	To be determined			
Concentration Level	All	**Field Sampling Organization**	ARCADIS Sampling Personnel			
Sampling Standard Operating Procedure (SOP)	SOP 2, SOP 7, SOP 8, SOP 20	**Analytical Organization**	Test America			
Quality Control (QC) Sample	**Frequency/Number[1]**	**Method/SOP QC Acceptance Limits**	**Corrective Action**	**Person(s) Responsible for Corrective Action**	**Data Quality Indicator**	**Measurement Performance Criteria**
Field duplicate	One per 10 field samples of similar matrix	Relative percent difference (RPD) < 35%	Qualify data as needed	Data Validator	Precision – overall	RPD < 35%
Method blanks	One per analytical batch	< CRQL	Qualify data as needed or reanalyze batch	Lab personnel and/or Data Validator	Accuracy/bias contamination	< CRQL
Equipment blanks	One per 20 field samples	< CRQL	Qualify data as needed	Data Validator	Accuracy/bias contamination	< CRQL
Calibration verification standards	Every 10 field samples and at the end of the analysis sequence	Percent recovery (%R) 85-115%	Reanalysis of batch	Lab personnel	Accuracy/bias contamination	%R 85-115%
Interference check sample (A and AB)	Two per run	%R ±20% of true value	Qualify data as needed or reanalysis of batch	Lab personnel	Precision – lab	%R ±20% of true value
Laboratory control sample (LCS) (ICP metals analysis only)	One per batch	%R 70-130% (50-150% for antimony and silver)	Qualify data as needed or reanalyze batch	Lab personnel and/or Data Validator	Precision	%R 70-130% (50-150% for antimony and silver)

Quality Assurance Project Plan Worksheet #28-5 – Quality Control Samples (Metals. Mercury, and Cyanide in Water by ISM01.3)

Matrix	Water	**Analytical Method/ SOP Reference**	ISM01.3/TAB-5, TAB-6, TAB-7	**No. of Sample Locations**	Numerous	
Analytical Group	Metals, Mercury, and Cyanide	**Sampler's Name**	To be determined			
Concentration Level	All	**Field Sampling Organization**	ARCADIS Sampling Personnel			
Sampling Standard Operating Procedure (SOP)	SOP 2, SOP 7, SOP 8, SOP 20	**Analytical Organization**	Test America			
Quality Control (QC) Sample	**Frequency/Number[1]**	**Method/SOP QC Acceptance Limits**	**Corrective Action**	**Person(s) Responsible for Corrective Action**	**Data Quality Indicator**	**Measurement Performance Criteria**
Matrix spike (MS)[2]	One per batch	%R: 75-125%; does not apply when the sample concentration is ≥4x the spike added	Qualify data as needed	Lab personnel and/or Data Validator	Accuracy/bias	%R: 75-125%; does not apply when the sample concentration is ≥4x the spike added
Matrix duplicate (MD)[2]	One per batch	RPD < 20% for original and duplicate sample values ≥5x the CRQL; control limit of the CRQL used if either the sample or duplicate value is <5x the CRQL	Qualify data as needed	Lab personnel and/or Data Validator	Precision	RPD < 20% for original and duplicate sample values ≥5x the CRQL; control limit of the CRQL used if either the sample or duplicate value is <5x the CRQL
Serial dilution (ICP metals analysis only)	One per batch	Percent difference (%D) < 10%	Qualify data as needed	Lab personnel	Precision	Percent difference (%D) < 10%

Notes:
[1]An analytical batch is defined as no more than 20 analytical samples including field samples and field blanks.
[2] MS/MD must be client-supplied.

Quality Assurance Project Plan Worksheet #28-6 – Quality Control Samples (Mercury in Water by EPA 1613E)

Matrix	Water	**Analytical Method/ SOP Reference**	EPA 1613E/TANC-12	**No. of Sample Locations**	Numerous	
Analytical Group	Mercury	**Sampler's Name**	To be determined			
Concentration Level	Low	**Field Sampling Organization**	ARCADIS Sampling Personnel			
Sampling Standard Operating Procedure (SOP)	SOP 2, SOP 7, SOP 8, SOP 20	**Analytical Organization**	Test America			
Quality Control (QC) Sample	**Frequency/Number[1]**	**Method/SOP QC Acceptance Limits**	**Corrective Action**	**Person(s) Responsible for Corrective Action**	**Data Quality Indicator**	**Measurement Performance Criteria**
Field duplicate	One per 10 field samples of similar matrix	Relative percent difference (RPD) < 35%	Qualify data as needed	Data Validator	Precision – overall	RPD < 35%
Method blanks	One per analytical batch	< RL	Qualify data as needed or reanalyze batch	Lab personnel and/or Data Validator	Accuracy/bias contamination	< RL
Equipment blanks	One per 20 field samples	< RL	Qualify data as needed	Data Validator	Accuracy/bias contamination	< RL
Calibration verification standards	Every 10 field samples and at the end of the analysis sequence	Percent recovery (%R), method specified limit	Reanalysis of batch	Lab personnel	Accuracy/bias contamination	%R 85-115%
Laboratory control sample (LCS)	One per batch	%R, method specified limit	Qualify data as needed or reanalyze batch	Lab personnel and/or Data Validator	Precision	%R, method specified limit
Matrix spike (MS)[2]	One per batch	%R, method specified limit	Qualify data as needed	Lab personnel and/or Data Validator	Accuracy/bias	%R, method specified limit

Quality Assurance Project Plan Worksheet #28-6 – Quality Control Samples (Mercury in Water by EPA 1613E)

Matrix	Water	**Analytical Method/ SOP Reference**	EPA 1613E/TANC-12	**No. of Sample Locations**	Numerous	
Analytical Group	Mercury	**Sampler's Name**	To be determined			
Concentration Level	Low	**Field Sampling Organization**	ARCADIS Sampling Personnel			
Sampling Standard Operating Procedure (SOP)	SOP 2, SOP 7, SOP 8, SOP 20	**Analytical Organization**	Test America			
Quality Control (QC) Sample	**Frequency/Number[1]**	**Method/SOP QC Acceptance Limits**	**Corrective Action**	**Person(s) Responsible for Corrective Action**	**Data Quality Indicator**	**Measurement Performance Criteria**
Matrix duplicate (MD)[2]	One per batch	RPD, method specified limit	Qualify data as needed	Lab personnel and/or Data Validator	Precision	RPD, method specified limit

Notes:
[1]An analytical batch is defined as no more than 20 analytical samples including field samples and field blanks.
[2] MS/MD must be client-supplied.

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Quality Assurance Project Plan Worksheet #28-7 – Quality Control Samples (Semivolatile Organic Compounds in Soil and Sediment by SOM01.2 and SOM01.2-SIM)

Matrix	Soil/Sediment	**Analytical Method/ SOP Reference**	SOM01.2/SOM01.2-SIM/TAB-3	**No. of Sample Locations**	Numerous	
Analytical Group	SVOCs	**Sampler's Name**	NA			
Concentration Level	All	**Field Sampling Organization**	ARCADIS Sampling Personnel			
Sampling SOP	SOP 5, SOP 14	**Analytical Organization**	Test America			
Quality Control (QC) Sample	**Frequency/Number[1]**	**Method/SOP QC Acceptance Limits**	**Corrective Action**	**Person(s) Responsible for Corrective Action**	**Data Quality Indicator (DQI)**	**Measurement Performance Criteria**
Field duplicate	One per 10 field samples of similar matrix	RPD < 50%	Qualify data as needed.	Data validator	Precision – overall	RPD < 50%
DMC	Added to all samples and blanks	%R, see SOM01.2 – Exhibit D Semivolatiles Tables 6 (%R) 7 (associated target compounds), and 8 (associated target compounds – SIM)	Check calculations, sample preparation logs, DMC standard spiking solution, and instrument operation. Re-extract/reanalyze samples. Qualify data as needed.	Laboratory analyst and/or data validator	Accuracy/bias	%R, see SOM01.2 – Exhibit D Semivolatiles Tables 6 (%R) 7 (associated target compounds), and 8 (associated target compounds – SIM)
Method blanks	One per analytical batch	< CRQL	Investigate source of contamination and re-extract/reanalyze associated samples. Qualify data as needed.	Laboratory analyst and/or data validator	Accuracy/bias contamination	< CRQL
Equipment blanks	One per 20 field samples	< CRQL	Qualify data as needed.	Data validator	Accuracy/bias contamination	< CRQL
Instrument check: DFTPP	One per calibration	%R, see SOM01.2 – Exhibit D Semivolatiles Table 1	Re-tune the instrument and reanalyze associated samples.	Laboratory analyst	Accuracy/bias	%R, see SOM01.2 – Exhibit D Semivolatiles Table 1

Quality Assurance Project Plan Worksheet #28-7 – Quality Control Samples (Semivolatile Organic Compounds in Soil and Sediment by SOM01.2 and SOM01.2-SIM)

Matrix	Soil/Sediment	**Analytical Method/ SOP Reference**	SOM01.2/SOM01.2-SIM/TAB-3	**No. of Sample Locations**	Numerous	
Analytical Group	SVOCs	**Sampler's Name**	NA			
Concentration Level	All	**Field Sampling Organization**	ARCADIS Sampling Personnel			
Sampling SOP	SOP 5, SOP 14	**Analytical Organization**	Test America			
Quality Control (QC) Sample	**Frequency/Number[1]**	**Method/SOP QC Acceptance Limits**	**Corrective Action**	**Person(s) Responsible for Corrective Action**	**Data Quality Indicator (DQI)**	**Measurement Performance Criteria**
Internal standard	Added to all samples and blanks	Area response 50.0% to 200% and retention time (RT) ±30.0 seconds from associated 12-hour calibration standard, see SOM01.2 – Exhibit D Semivolatiles Table 2 (associated target compounds)	Check calculations, internal standard solutions, and instrument operation. Re-extract/reanalyze samples. Qualify data as needed.	Laboratory analyst and/or data validator	Precision	Area response 50.0% to 200% and retention time (RT) ±30.0 seconds from associated 12-hour calibration standard, see SOM01.2 – Exhibit D Semivolatiles Table 2 (associated target compounds)
MS[2]	One per batch	%R, see SOM01.2 - Exhibit D Semivolatile Table 5	Re-extract/reanalyze samples. Qualify data as needed	Laboratory analyst and/or data validator	Accuracy/bias	%R, see SOM01.2 - Exhibit D Semivolatile Table 5
MSD[2]	One per batch	%R, see SOM01.2 - Exhibit D Semivolatile Table 5	Re-extract/reanalyze samples. Qualify data as needed	Laboratory analyst and/or data validator	Accuracy/bias	%R, see SOM01.2 - Exhibit D Semivolatile Table 5
MS/MSD[2]	One per batch	%R, see SOM01.2 - Exhibit D Semivolatile Table 5	Re-extract/reanalyze samples. Qualify data as needed	Laboratory analyst and/or data validator	Precision	%R, see SOM01.2 - Exhibit D Semivolatile Table 5

Note:

[1] An analytical batch is defined as no more than 20 analytical samples including field samples and field blanks.

[2] MS and MSD must be client-provided.

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Quality Assurance Project Plan Worksheet #28-8 – Quality Control Samples (Volatile Organic Compounds in Soil and Sediment by SOM01.2)

Matrix	Soil/Sediment	**Analytical Method/ SOP Reference**	SOM01.2-TAB-4	**No. of Sample Locations**	Numerous	
Analytical Group	VOCs	**Sampler's Name**	NA			
Concentration Level	All	**Field Sampling Organization**	ARCADIS Sampling Personnel			
Sampling SOP	SOP 5, SOP 14	**Analytical Organization**	Test America			
Quality Control (QC) Sample	**Frequency/Number[1]**	**Method/SOP QC Acceptance Limits**	**Corrective Action**	**Person(s) Responsible for Corrective Action**	**Data Quality Indicator (DQI)**	**Measurement Performance Criteria**
Field duplicate	One per 10 field samples of similar matrix	RPD < 50%	Qualify data as needed.	Data validator	Precision – overall	RPD < 50%
DMC	Added to all samples and blanks	%R, see SOM01.2 – Exhibit D Low/Medium Volatiles Tables 5 (%R) and 7 (associated target compounds)	Check calculations, sample preparation logs, DMC standard spiking solution, and instrument operation. Re-extract/reanalyze samples. Qualify data as needed.	Laboratory analyst and/or data validator	Accuracy/bias	%R, see SOM01.2 – Exhibit D Low/Medium Volatiles Tables 5 (%R) and 7 (associated target compounds)
Method blanks	One per analytical batch	< CRQL	Investigate source of contamination and re-extract/reanalyze associated samples. Qualify data as needed.	Laboratory analyst and/or data validator	Accuracy/bias contamination	< CRQL
Equipment blanks	One per 20 field samples	< CRQL	Qualify data as needed.	Data validator	Accuracy/bias contamination	< CRQL

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Quality Assurance Project Plan Worksheet #28-8 – Quality Control Samples (Volatile Organic Compounds in Soil and Sediment by SOM01.2)

Matrix	Soil/Sediment	**Analytical Method/ SOP Reference**	SOM01.2-TAB-4	**No. of Sample Locations**	Numerous	
Analytical Group	VOCs	**Sampler's Name**	NA			
Concentration Level	All	**Field Sampling Organization**	ARCADIS Sampling Personnel			
Sampling SOP	SOP 5, SOP 14	**Analytical Organization**	Test America			
Quality Control (QC) Sample	**Frequency/Number[1]**	**Method/SOP QC Acceptance Limits**	**Corrective Action**	**Person(s) Responsible for Corrective Action**	**Data Quality Indicator (DQI)**	**Measurement Performance Criteria**
Instrument check: BFB	One per calibration	%R, see SOM01.2 – Exhibit D Low/Medium Volatiles Table 1	Re-tune the instrument and reanalyze associated samples.	Laboratory analyst	Accuracy/bias	%R, see SOM01.2 – Exhibit D Low/Medium Volatiles Table 1
Internal standard	Added to all samples and blanks	Area response 50.0% to 200% and retention time (RT) ±30.0 seconds from associated 12-hour calibration standard, see SOM01.2 – Exhibit D Low/Medium Volatiles Table 3 (associated target compounds)	Check calculations, internal standard solutions, and instrument operation. Re-extract/reanalyze samples. Qualify data as needed.	Laboratory analyst and/or data validator	Precision	Area response 50.0% to 200% and retention time (RT) ±30.0 seconds from associated 12-hour calibration standard, see SOM01.2 – Exhibit D Semivolatiles Table 2 (associated target compounds)
MS[2]	One per batch	%R, see SOM01.2 - Exhibit D Low/Medium Volatiles Table 6	Re-extract/reanalyze samples. Qualify data as needed	Laboratory analyst and/or data validator	Accuracy/bias	%R, see SOM01.2 - Exhibit D Low/Medium Volatiles Table 6
MSD[2]	One per batch	%R, see SOM01.2 - Exhibit D Low/Medium Volatiles Table 6	Re-extract/reanalyze samples. Qualify data as needed	Laboratory analyst and/or data validator	Accuracy/bias	%R, see SOM01.2 - Exhibit D Low/Medium Volatiles Table 6

Quality Assurance Project Plan Worksheet #28-8 – Quality Control Samples (Volatile Organic Compounds in Soil and Sediment by SOM01.2)

Matrix	Soil/Sediment	**Analytical Method/ SOP Reference**	SOM01.2-TAB-4	**No. of Sample Locations**	Numerous	
Analytical Group	VOCs	**Sampler's Name**	NA			
Concentration Level	All	**Field Sampling Organization**	ARCADIS Sampling Personnel			
Sampling SOP	SOP 5, SOP 14	**Analytical Organization**	Test America			
Quality Control (QC) Sample	**Frequency/Number[1]**	**Method/SOP QC Acceptance Limits**	**Corrective Action**	**Person(s) Responsible for Corrective Action**	**Data Quality Indicator (DQI)**	**Measurement Performance Criteria**
MS/MSD[2]	One per batch	%R, see SOM01.2 - Exhibit D Low/Medium Volatiles Table 6	Re-extract/reanalyze samples. Qualify data as needed	Laboratory analyst and/or data validator	Precision	%R, see SOM01.2 - Exhibit D Low/Medium Volatiles Table 6

Note:
[1] An analytical batch is defined as no more than 20 analytical samples including field samples and field blanks.
[2] MS and MSD must be client-provided.

Quality Assurance Project Plan Worksheet #28-9 – Quality Control Samples (Pesticides in Soil and Sediment by SOM01.2)

Matrix	Soil/Sediment	**Analytical Method/ SOP Reference**	SOM01.2/TAB-2	**No. of Sample Locations**	Numerous	
Analytical Group	Pesticides	**Sampler's Name**	NA			
Concentration Level	All	**Field Sampling Organization**	ARCADIS Sampling Personnel			
Sampling SOP	SOP 5, SOP 14	**Analytical Organization**	Test America			
QC Sample	**Frequency/Number[1]**	**Method/SOP QC Acceptance Limits[3]**	**Corrective Action**	**Person(s) Responsible for Corrective Action**	**DQI**	**Measurement Performance Criteria**

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Quality Assurance Project Plan Worksheet #28-9 – Quality Control Samples (Pesticides in Soil and Sediment by SOM01.2)

Matrix	Soil/Sediment	**Analytical Method/ SOP Reference**	SOM01.2/TAB-2	**No. of Sample Locations**	Numerous	
Analytical Group	Pesticides	**Sampler's Name**	NA			
Concentration Level	All	**Field Sampling Organization**	ARCADIS Sampling Personnel			
Sampling SOP	SOP 5, SOP 14	**Analytical Organization**	Test America			
QC Sample	**Frequency/Number[1]**	**Method/SOP QC Acceptance Limits[3]**	**Corrective Action**	**Person(s) Responsible for Corrective Action**	**DQI**	**Measurement Performance Criteria**
Field duplicate	One per 10 field samples of similar matrix	RPD < 50%	Qualify data as needed	Data validator	Precision – overall	RPD < 50%
Surrogate spikes	Added to all samples and blanks	%R: 30-150%	Check calculations, sample preparation logs, surrogate spiking solution, and instrument operation. Re-extract/reanalyze samples. Qualify data as needed.	Laboratory analyst and/or data validator	Accuracy/bias	%R: 30-150%
Method blanks	One per analytical batch	< CRQL	Investigate source of contamination and re-extract/reanalyze associated samples. Qualify data as needed.	Laboratory analyst and/or data validator	Accuracy/bias contamination	< CRQL
Equipment blanks	One per 20 field samples	< CRQL	Qualify data as needed	Data validator	Accuracy/bias contamination	< CRQL
LCS	One per analytical batch	%R, see SOM01.2 - Exhibit D Pesticides Table 2	Re-extract/reanalyze associated samples. Qualify data as needed	Laboratory analyst and/or data validator	Accuracy/bias	%R, see SOM01.2 - Exhibit D Pesticides Table 2
MS[2]	One per analytical batch	%R, see SOM01.2 - Exhibit D Pesticides Table 3	Re-extract/reanalyze samples. Qualify data as needed	Laboratory analyst and/or data validator	Accuracy/bias	%R, see SOM01.2 - Exhibit D Pesticides Table 3

Quality Assurance Project Plan Worksheet #28-9 – Quality Control Samples (Pesticides in Soil and Sediment by SOM01.2)

Matrix	Soil/Sediment	**Analytical Method/ SOP Reference**	SOM01.2/TAB-2	**No. of Sample Locations**	Numerous	
Analytical Group	Pesticides	**Sampler's Name**	NA			
Concentration Level	All	**Field Sampling Organization**	ARCADIS Sampling Personnel			
Sampling SOP	SOP 5, SOP 14	**Analytical Organization**	Test America			
QC Sample	**Frequency/Number[1]**	**Method/SOP QC Acceptance Limits[3]**	**Corrective Action**	**Person(s) Responsible for Corrective Action**	**DQI**	**Measurement Performance Criteria**
MSD[2]	One per analytical batch	%R, see SOM01.2 - Exhibit D Pesticides Table 3	Re-extract/reanalyze samples. Qualify data as needed	Laboratory analyst and/or data validator	Accuracy/bias	%R, see SOM01.2 - Exhibit D Pesticides Table 3
MS/MSD[2]	One per analytical batch	%R, see SOM01.2 - Exhibit D Pesticides Table 3	Re-extract/reanalyze samples. Qualify data as needed	Laboratory analyst and/or data validator	Precision	%R, see SOM01.2 - Exhibit D Pesticides Table 3

Note:
[1] An analytical batch is defined as no more than 20 analytical samples including field samples and field blanks.
[2] MS and MSD must be client-provided.

Quality Assurance Project Plan Worksheet #28-10 – Quality Control Samples (PCBs in Soil and Sediment by SOM01.2)

Matrix	Soil/Sediment	**Analytical Method/ SOP Reference**	SOM01.2/TAB-1	**No. of Sample Locations**	Numerous	
Analytical Group	PCBs	**Sampler's Name**	NA			
Concentration Level	All	**Field Sampling Organization**	ARCADIS Sampling Personnel			
Sampling SOP	SOP 5, SOP 14	**Analytical Organization**	Test America			
QC Sample	**Frequency/Number[1]**	**Method/SOP QC Acceptance Limits[3]**	**Corrective Action**	**Person(s) Responsible for Corrective Action**	**DQI**	**Measurement Performance Criteria**
Field duplicate	One per 10 field samples of similar matrix	RPD < 50%	Qualify data as needed	Data validator	Precision – overall	RPD < 50%
Surrogate spikes	Added to all samples and blanks	%R: 30-150%	Check calculations, sample preparation logs, surrogate spiking solution, and instrument operation. Re-extract/reanalyze samples. Qualify data as needed.	Laboratory analyst and/or data validator	Accuracy/bias	%R: 30-150%
Method blanks	One per analytical batch	< CRQL	Investigate source of contamination and re-extract/reanalyze associated samples. Qualify data as needed.	Laboratory analyst and/or data validator	Accuracy/bias contamination	< CRQL
Equipment blanks	One per 20 field samples	< CRQL	Qualify data as needed	Data validator	Accuracy/bias contamination	< CRQL
LCS	One per analytical batch	%R, see SOM01.2 - Exhibit D Aroclors Table 2	Re-extract/reanalyze associated samples. Qualify data as needed	Laboratory analyst and/or data validator	Accuracy/bias	%R, see SOM01.2 - Exhibit D Aroclors Table 2
MS[2]	One per analytical batch	%R, see SOM01.2 - Exhibit D Aroclors Table 1	Re-extract/reanalyze samples. Qualify data as needed	Laboratory analyst and/or data validator	Accuracy/bias	%R, see SOM01.2 - Exhibit D Aroclors Table 1

Quality Assurance Project Plan Worksheet #28-10 – Quality Control Samples (PCBs in Soil and Sediment by SOM01.2)

Matrix	Soil/Sediment	**Analytical Method/ SOP Reference**	SOM01.2/TAB-1	**No. of Sample Locations**	Numerous	
Analytical Group	PCBs	**Sampler's Name**	NA			
Concentration Level	All	**Field Sampling Organization**	ARCADIS Sampling Personnel			
Sampling SOP	SOP 5, SOP 14	**Analytical Organization**	Test America			
QC Sample	**Frequency/Number[1]**	**Method/SOP QC Acceptance Limits[3]**	**Corrective Action**	**Person(s) Responsible for Corrective Action**	**DQI**	**Measurement Performance Criteria**
MSD[2]	One per analytical batch	%R, see SOM01.2 - Exhibit D Aroclors Table 1	Re-extract/reanalyze samples. Qualify data as needed	Laboratory analyst and/or data validator	Accuracy/bias	%R, see SOM01.2 - Exhibit D Aroclors Table 1
MS/MSD[2]	One per analytical batch	%R, see SOM01.2 - Exhibit D Aroclors Table 1	Re-extract/reanalyze samples. Qualify data as needed	Laboratory analyst and/or data validator	Precision	%R, see SOM01.2 - Exhibit D Aroclors Table 1

Note:
[1] An analytical batch is defined as no more than 20 analytical samples including field samples and field blanks.
[2] MS and MSD must be client-provided.

Quality Assurance Project Plan Worksheet #28-11 – Quality Control Samples (Metals. Mercury, and Cyanide in Soil and Sediment by ISM01.3)

Matrix	Soil/Sediment	**Analytical Method/ SOP Reference**	ISM01.3/TAB-5, TAB-6, TAB-7	**No. of Sample Locations**	Numerous	
Analytical Group	Metals, Mercury, and Cyanide	**Sampler's Name**	To be determined			
Concentration Level	All	**Field Sampling Organization**	ARCADIS Sampling Personnel			
Sampling Standard Operating Procedure (SOP)	SOP 5, SOP 14	**Analytical Organization**	Test America			
Quality Control (QC) Sample	**Frequency/Number[1]**	**Method/SOP QC Acceptance Limits**	**Corrective Action**	**Person(s) Responsible for Corrective Action**	**Data Quality Indicator**	**Measurement Performance Criteria**
Field duplicate	One per 10 field samples of similar matrix	Relative percent difference (RPD) < 50%	Qualify data as needed	Data Validator	Precision – overall	RPD < 50%
Method blanks	One per analytical batch	< CRQL	Qualify data as needed or reanalyze batch	Lab personnel and/or Data Validator	Accuracy/bias contamination	< CRQL
Equipment blanks	One per 20 field samples	< CRQL	Qualify data as needed	Data Validator	Accuracy/bias contamination	< CRQL
Calibration verification standards	Every 10 field samples and at the end of the analysis sequence	Percent recovery (%R) 85-115%	Reanalysis of batch	Lab personnel	Accuracy/bias contamination	%R 85-115%
Interference check sample (A and AB)	Two per run	%R ±20% of true value	Qualify data as needed or reanalysis of batch	Lab personnel	Precision – lab	%R ±20% of true value
Laboratory control sample (LCS) (ICP metals analysis only)	One per batch	%R 70-130% (50-150% for antimony and silver)	Qualify data as needed or reanalyze batch	Lab personnel and/or Data Validator	Precision	%R 70-130% (50-150% for antimony and silver)

Quality Assurance Project Plan Worksheet #28-11 – Quality Control Samples (Metals. Mercury, and Cyanide in Soil and Sediment by ISM01.3)

Matrix	Soil/Sediment	**Analytical Method/ SOP Reference**	ISM01.3/TAB-5, TAB-6, TAB-7	**No. of Sample Locations**	Numerous	
Analytical Group	Metals, Mercury, and Cyanide	**Sampler's Name**	To be determined			
Concentration Level	All	**Field Sampling Organization**	ARCADIS Sampling Personnel			
Sampling Standard Operating Procedure (SOP)	SOP 5, SOP 14	**Analytical Organization**	Test America			
Quality Control (QC) Sample	**Frequency/Number[1]**	**Method/SOP QC Acceptance Limits**	**Corrective Action**	**Person(s) Responsible for Corrective Action**	**Data Quality Indicator**	**Measurement Performance Criteria**
Matrix spike (MS)[2]	One per batch	%R: 75-125%; does not apply when the sample concentration is ≥4x the spike added	Qualify data as needed	Lab personnel and/or Data Validator	Accuracy/bias	%R: 75-125%; does not apply when the sample concentration is ≥4x the spike added
Matrix duplicate (MD)[2]	One per batch	RPD < 20% for original and duplicate sample values ≥5x the CRQL; control limit of the CRQL used if either the sample or duplicate value is <5x the CRQL	Qualify data as needed	Lab personnel and/or Data Validator	Precision	RPD < 20% for original and duplicate sample values ≥5x the CRQL; control limit of the CRQL used if either the sample or duplicate value is <5x the CRQL
Serial dilution (ICP metals analysis only)	One per batch	Percent difference (%D) < 10%	Qualify data as needed	Lab personnel	Precision	Percent difference (%D) < 10%

Notes:
[1]An analytical batch is defined as no more than 20 analytical samples including field samples and field blanks.
[2] MS/MD must be client-supplied.

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Quality Assurance Project Plan Worksheet #28-12 Quality Control Samples (Total Organic Carbon in Soil and Sediment by Lloyd Kahn)

Matrix	Soil/Sediment	**Analytical Method/ SOP Reference**	Lloyd Kahn/TAB-12	**No. of Sample Locations**	Numerous	
Analytical Group	TOC	**Sampler's Name**	Not Available			
Concentration Level	All	**Field Sampling Organization**	ARCADIS Sampling Personnel			
Sampling SOP	SOP 5, SOP 14	**Analytical Organization**	Test America			
QC Sample	**Frequency/Number**	**Method/SOP QC Acceptance Limits**	**Corrective Action**	**Person(s) Responsible for Corrective Action**	**DQI**	**Measurement Performance Criteria**
Field duplicate	One per 10 field samples of similar matrix	RPD < 50%	Qualify data as needed	Data validator	Precision – overall	RPD < 50%
LCS	One per analytical batch	%R, laboratory specific limits	Re-prepare/reanalyze samples. Qualify data as needed.	Laboratory analyst and/or data validator	Accuracy/bias	%R, laboratory specific limits
Laboratory duplicate[2]	One per analytical batch	RPD, laboratory specific limits	Re-prepare/reanalyze samples. Qualify data as needed.	Laboratory analyst and/or data validator	Precision – overall	RPD, laboratory specific limits
MS[2]	One per analytical batch	%R, laboratory specific limits	Re-prepare/reanalyze samples. Qualify data as needed.	Laboratory analyst and/or data validator	Accuracy/bias	%R, laboratory specific limits

Note:
[1] An analytical batch is defined as no more than 20 analytical samples including field samples and field blanks.
[2] Sufficient sample size for MS and laboratory duplicate analysis must be client-provided.

Quality Assurance Project Plan Worksheet #28-13 – Quality Control Samples (PCB Congeners in Soil and Sediment by EPA 1668A)

Matrix	Soil/Sediment	**Analytical Method/ SOP Reference**	EPA 1668A/TAWS-1	**No. of Sample Locations**	Numerous	
Analytical Group	PCB Congeners	**Sampler's Name**	NA			
Concentration Level	All	**Field Sampling Organization**	ARCADIS Sampling Personnel			
Sampling SOP	SOP 5, SOP 14	**Analytical Organization**	Test America			
QC Sample	**Frequency/Number[1]**	**Method/SOP QC Acceptance Limits**	**Corrective Action**	**Person(s) Responsible for Corrective Action**	**DQI**	**Measurement Performance Criteria**
Field duplicate	One per 10 field samples of similar matrix	RPD < 50%	Qualify data as needed	Data validator	Precision – overall	RPD < 50%
Ongoing precision and recovery (OPR)	One per analytical batch	%R, method specified limits	Correct the problem. Re-prepare, extract, and clean-up the sample batch and repeat the OPR.	Laboratory analyst and/or data validator	Accuracy/bias	%R, method specified limits
Method blanks	One per analytical batch	< RL	Investigate source of contamination and re-extract/reanalyze associated samples. Qualify data as needed.	Laboratory analyst and/or data validator	Accuracy/bias contamination	< RL
Equipment blanks	One per 20 field samples	< RL	Qualify data as needed.	Data validator	Accuracy/bias contamination	< RL
Internal standards	Added to all samples	%R, method specified limits	Reanalyze sample. Qualify data as needed.	Laboratory analyst and/or data validator	Accuracy/bias	%R, method specified limits
MS[2]	One per analytical batch	%R, method specified limits	Re-extract/reanalyze associated samples. Qualify data as needed.	Laboratory analyst and/or data validator	Accuracy/bias	%R, method specified limits

Quality Assurance Project Plan Worksheet #28-13 – Quality Control Samples (PCB Congeners in Soil and Sediment by EPA 1668A)

Matrix	Soil/Sediment	**Analytical Method/ SOP Reference**	EPA 1668A/TAWS-1	**No. of Sample Locations**	Numerous	
Analytical Group	PCB Congeners	**Sampler's Name**	NA			
Concentration Level	All	**Field Sampling Organization**	ARCADIS Sampling Personnel			
Sampling SOP	SOP 5, SOP 14	**Analytical Organization**	Test America			
QC Sample	**Frequency/Number[1]**	**Method/SOP QC Acceptance Limits**	**Corrective Action**	**Person(s) Responsible for Corrective Action**	**DQI**	**Measurement Performance Criteria**
MSD or LCSD[2]	One per analytical batch	%R, method specified limits	Re-extract/reanalyze samples. Qualify data as needed.	Laboratory analyst and/or data validator	Accuracy/bias	%R, method specified limits
MS/MSD and LCS/LCSD[2]	One per analytical batch	RPD, method specified limits	Re-extract/reanalyze samples. Qualify data as needed.	Laboratory analyst and/or data validator	Precision	RPD, method specified limits

Note:
[1] An analytical batch is defined as no more than 20 analytical samples including field samples and field blanks.
[2] LCS/LCSD used when MS/MSD are not client-supplied.

Quality Assurance Project Plan Worksheet #28-14 – Quality Control Samples (Dioxins and Furans in Soil and Sediment by EPA 1613)

Matrix	Soil	**Analytical Method/ SOP Reference**	EPA 1613/TAWS-2	**No. of Sample Locations**	Numerous	
Analytical Group	Dioxins and Furans	**Sampler's Name**	TBD			
Concentration Level	All	**Field Sampling Organization**	ARCADIS Sampling Personnel			
Sampling Standard Operating Procedure (SOP)	SOP 5, SOP 14	**Analytical Organization**	Test America			
Quality Control (QC) Sample	**Frequency/Number[1]**	**Method/SOP QC Acceptance Limits**	**Corrective Action**	**Person(s) Responsible for Corrective Action**	**Data Quality Indicator (DQI)**	**Measurement Performance Criteria**
Field duplicate	One per 10 field samples of similar matrix	Relative percent difference (RPD) < 50%	Qualify data as needed	Data Validator	Precision – overall	RPD < 50%
Internal standards/ recovery standards	9 IS/2 RS per sample and lab QC samples	Percent recovery (%R), method specified limit	Reanalysis or re-extraction/reanalysis of sample	Lab personnel	Accuracy/bias	%R, method specified limit
Method blanks	One per analytical batch	< RL	Qualify data as needed or re-extraction/reanalysis of batch	Lab personnel and/or Data Validator	Accuracy/bias contamination	< RL
Equipment blanks	One per 20 field samples	< RL	Qualify data as needed	Data Validator	Accuracy/bias contamination	< RL
Laboratory control sample/laboratory control sample duplicate (LCS/LCSD)[2]	One per analytical batch	%R, method specified limit	Reanalysis or re-extraction/ reanalysis of batch	Lab personnel and/or Data Validator	Accuracy/bias	%R, method specified limit
Instrument performance check: Perfluorokerosene (PKF)	One per calibration	Method specified limit	Reanalyze batch	Lab personnel	Accuracy/bias	%R, method specified limit

Quality Assurance Project Plan Worksheet #28-14 – Quality Control Samples (Dioxins and Furans in Soil and Sediment by EPA 1613)

Matrix	Soil	**Analytical Method/ SOP Reference**	EPA 1613/TAWS-2	**No. of Sample Locations**	Numerous	
Analytical Group	Dioxins and Furans	**Sampler's Name**	TBD			
Concentration Level	All	**Field Sampling Organization**	ARCADIS Sampling Personnel			
Sampling Standard Operating Procedure (SOP)	SOP 5, SOP 14	**Analytical Organization**	Test America			
Quality Control (QC) Sample	**Frequency/Number[1]**	**Method/SOP QC Acceptance Limits**	**Corrective Action**	**Person(s) Responsible for Corrective Action**	**Data Quality Indicator (DQI)**	**Measurement Performance Criteria**
Matrix spike/matrix spike duplicate (MS/MSD)[2]	One per batch	%R, method specified limit	Qualify data as needed	Lab personnel and/or Data Validator	Accuracy/bias	%R, method specified limit
MS/MSD and LCS/LCSD[2]	One per batch	%RPD, method specified limit	Qualify data as needed	Lab personnel and/or Data Validator	Precision	%RPD, method specified limit

Note: [1]An analytical batch is defined as no more than 20 analytical samples including field samples and field blanks.
[2]LCS/LCSD used when MS/MSD are not client-supplied.

QAPP Worksheet #29: Project Documents and Records

Sample Collection Documents and Records	On-Site Analysis Documents and Records	Off-Site Analysis Documents and Records	Data Assessment Documents and Records	Other
- Field Notes - Sampling Logs - Chain-of-Custody Records - Air Bills - Custody Seals	- Equipment Calibration Logs - Field Data Records - Field Instrument Maintenance Logs	- Sample Receipt, Custody and Tracking Records - Standard Traceability Logs - Equipment Calibration Logs - Sample Prep Logs - Run Logs - Equipment Maintenance, Testing and Inspection Logs - Corrective Action Forms - Reported Field Sample Results - Reported Results for Standards, Quality Control (QC) Checks and QC Samples - Instrument PDF of (raw data) for Field Samples, Standards, QC Checks and QC Samples - Data Package Completeness Checklists - Sample Disposal Records - Extraction/Cleanup Records - Raw Data (stored on disk or CD-R) - Analytical Reports to ARCADIS	- Data Validation Checklists - Data Quality Assessments	Site-specific Work Plans as needed Site-specific Safety and Health Plan

QAPP Worksheet #31, 32 & 33: Assessments and Corrective Action

Assessments:

Assessment Type	Responsible Party & Organization	Number/Frequency	Estimated Dates	Assessment Deliverable	Deliverable due date
Readiness Review	Suzanne Walls, ARCADIS	One assessment one week prior to mobilization	Approximately 15 October 2014	Readiness Review Memorandum	24 hours following assessment
Field Sampling TSA	Andrew Gutherz, ARCADIS	One each on first day of soil and temporary well groundwater sampling	Approximately 22 October 2014	TSA Memorandum	24 hours following assessment
Management Review	John Persico, ARCADIS	Interim Management Review following site mobilization. Final management review upon completion of field work.	Interim review – approximately 10 November 2014. Final review – approximately 1 February 2015	QA Management Report	48 hours following Management Review

Assessment Response and Corrective Action:

Assessment Type	Responsibility for responding to assessment findings	Assessment Response Documentation	Timeframe for Response	Responsibility for Implementing Corrective Action	Responsible for monitoring Corrective Action implementation
Readiness Review	John Persico, ARCADIS	Readiness Review Corrective Action Response	24 hours from receipt of Readiness Review Memorandum	As directed by PM	As directed by PM
Field Sampling TSA	Suzanne Walls, ARCADIS	Field Sampling Corrective Action Response	24 hours from receipt of Memorandum	Field Task Leader	Field Task Leader
Management Reviews	Suzanne Walls, ARCADIS	QA Management Response	48 hours from receipt of QA Management Report	As assigned in QA Management Response	As assigned in QA Management Response

QAPP Worksheet #34: Data Verification and Validation Inputs

Item	Description	Verification (completeness)	Validation (conformance to specifications)
	Planning Documents/Records		
1	Approved QAPP	X	
2	Contract	X	
4	Field SOPs	X	
5	Laboratory SOPs	X	
	Field Records		
6	Field logbooks	X	
7	Equipment calibration records	X	
8	Chain-of-Custody Forms	X	
9	Sampling logs	X	
10	Drilling logs	X	
13	Change orders/deviations	X	
14	Field audit reports	X	
15	Field corrective action reports	X	
	Analytical Data Package		
16	Cover sheet (laboratory identifying information)	X	X
17	Case narrative	X	X
18	Internal laboratory chain-of-custody	X	X
19	Sample receipt records	X	X
20	Sample chronology (i.e. dates and times of receipt, preparation, & analysis)	X	X
21	Communication records	X	X
22	Project-specific PT sample results	X	X
23	LOD/LOQ establishment and verification	X	X
24	Standards Traceability	X	X
25	Instrument calibration records	X	X
26	Definition of laboratory qualifiers	X	X
27	Results reporting forms	X	X
28	QC sample results	X	X
29	Corrective action reports	X	X
30	Raw data	X	X
31	Electronic data deliverable	X	

QAPP Worksheet #35: Data Verification Procedures

Records Reviewed	Requirement Documents	Process Description	Responsible Person, Organization
Field logbook and purge forms	QAPP	Verify that records are present and complete for each day of field activities. Verify that all planned samples including field QC samples were collected and that sample collection locations are documented. Verify that changes/exceptions are documented and were reported in accordance with requirements. Verify that any required field monitoring was performed and results are documented.	Weekly – Project Manager
Chain-of-custody forms	QAPP	Verify the completeness of chain-of-custody records. Check that appropriate methods and sample preservation have been recorded. Verify that the required volume of sample has been collected and that sufficient sample volume is available for QC samples (e.g., field duplicates, surrogates, blanks, and MS/MSD). Verify that all required signatures and dates are present. Check for transcription errors.	Daily – Field Crew Chief At conclusion of field activities – Project Manager
Laboratory Deliverable		Verify that the laboratory deliverable contains all records specified in the QAPP. Check sample receipt records to ensure sample condition upon receipt was noted, and any missing/broken sample containers were noted and reported according to plan. Compare the data package with the CoCs to verify that results were provided for all collected samples. Review the narrative to ensure all QC exceptions are described. Check for evidence that any required notifications were provided to project personnel as specified in the QAPP. Verify that necessary signatures and dates are present.	Before release – Laboratory QAM Upon receipt – Project Manager

QAPP Worksheet #36
Data Validation Procedures

Quality Assurance Project Plan Worksheet #36 – Validation (Steps IIa and IIb) Summary

Steps IIa and IIb	Matrix	Analytical Group	Data Purpose	Concentration Level	Validation Criteria[1]	Data Validator (title and organizational affiliation)
IIa and IIb	Sediments and Soil	Volatile Organic Compounds (VOCs), Semi-Volatile Organic Compounds (SVOCs) TCL/SIM, Polychlorinated Biphenyls (PCBs), Pesticides, PCBs Congener, Dioxins/Furans, TAL Metals, pH, TOC	Data Gaps	All	USEPA Contract Laboratory Program National Functional Guidelines for Superfund Organic Methods Data Review SOM 1.2 June 2008, and USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Superfund Data Review ISM 1.2 January 2010; EPA Region II Data Validation SOP for Dioxins EPA method 1613 HW-25 September 2008, EPA Region II Data Validation SOP for PCB congeners EPA method 1668 August 2003; Quality Assurance Project Plan (QAPP) criteria; associated analytical methodology, and professional judgment	Lyndi Mott Project Chemist, ARCADIS
IIa and IIb	Water	Volatile Organic Compounds (VOCs), Semi-Volatile Organic Compounds (SVOCs) TCL/SIM, Polychlorinated Biphenyls (PCBs), Pesticides, TAL Metals, LL Mercury, pH, TOC	Data Gaps	All	USEPA Contract Laboratory Program National Functional Guidelines for Superfund Organic Methods Data Review SOM 1.2 June 2008, and USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Superfund Data Review ISM 1.2 January 2010; Quality Assurance Project Plan (QAPP) criteria, associated analytical methodology; and professional judgment	Lyndi Mott Project Chemist, ARCADIS

QAPP Worksheet #37: Data Usability Assessment

Identify personnel (organization and position/title) responsible for participating in the data usability assessment:

- John Persico, ARCADIS Project Coordinator
- Suzanne Walls, ARCADIS Project Manager
- Dennis Capria, ARCADIS QA Manager

The data usability assessment will be performed by the ARCADIS project management staff. Data verification will involve assessing whether analytical data meet the QC objectives and whether the necessary quality control steps were performed during field and laboratory tasks. The key data that will be assessed during data verification include:

- Sample collection, handling and analysis procedures in the field and laboratory
- Laboratory data (laboratory-qualified)
- Data package deliverable completeness
- QC sample data summaries

Quality Assurance Project Plan Worksheet #37 – Usability Assessment

The Data Usability Assessment will be performed by ARCADIS for data associated with the Data QAP Work Plan at the Rolling Knolls site. Documentation generated during the Data Usability Assessment will consist of data validation checklists with a brief summary of overall data usability.

The Data Usability Assessment process involves data verification and validation. Data verification is the process by which laboratory results are checked to provide that the proper quality control (QC) steps were performed and key items have met QC objectives (both analytical and contractual). Key steps of an ARCADIS data verification include:

- identifying sample collection, handling and analysis procedures
- documenting handling and analysis activities (e.g., , QC checklist)
- verifying (internally, at the data generator level) all sampling, handling, on-site analytical laboratory data

Quality Assurance Project Plan Worksheet #37 – Usability Assessment

- verifying laboratory data (e.g., laboratory-qualified data)
- verifying sampling, on-site analytical laboratory data
- verifying data package deliverable completeness
- reviewing the case narrative
- presenting all analytical results
- summarizing QC sample data
- evaluating applicable raw data

All required data deliverables must be present in the data package in order to proceed to the next step of data validation.

Data validation entails a review of the sample collection, handling, QC data, and the raw data to verify that the laboratory was operating within required limits, analytical results were correctly transcribed from the instrument read-outs and which (if any) environmental samples were related to out-of-control QC samples. The objective of data validation is to identify any questionable or invalid laboratory measurements.

The data quality indicators (DQIs) used to evaluate conformance with the project data quality objectives (DQOs) are presented below.

DQIs are generally defined in terms of six parameters:

1. representativeness
2. comparability
3. completeness
4. precision
5. accuracy
6. sensitivity

Quality Assurance Project Plan Worksheet #37 – Usability Assessment

Each parameter is defined below. Specific objectives for the site actions are presented in other sections of this QAPP, as referenced below.

Representativeness

Representativeness is the degree to which sampling data accurately and precisely represent site conditions, and is dependent on sampling and analytical variability and the variability of environmental media at the site. Actions have been designed to assess the presence of chemical constituents at the time of sampling. The QAPP presents the rationale for sample quantities and location. This QAPP presents field sampling and laboratory analytical methodologies. Use of the prescribed field and laboratory analytical methods with associated holding times and preservation requirements are intended to provide representative data.

Comparability

Comparability is the degree of confidence with which one data set can be compared to another. Comparability between phases of the actions (if additional phases are required) will be maintained through consistent use of the sampling and analytical methodologies set forth in this QAPP, established quality assurance/quality control (QA/QC) procedures and use of appropriately trained personnel.

Completeness

Completeness is defined as a measure of the amount of valid data obtained from an event and/or investigation compared to the total amount that was obtained. This will be determined upon final assessment of the analytical results. Completeness of a field or laboratory data set will be calculated by comparing the number of valid sample results generated to the total number of results generated.

$$\text{Completeness} = \frac{\text{Number valid results}}{\text{Total number of results generated}} \times 100$$

As a general guideline, overall project completeness is expected to be at least 90 percent. The assessment of completeness will require professional judgment to determine data usability for intended purposes.

Quality Assurance Project Plan Worksheet #37 – Usability Assessment

Precision

Precision is a measure of the reproducibility of sample results. The goal is to maintain a level of analytical precision consistent with the objectives of the action. To maximize precision, sampling and analytical procedures will be followed. All work for the site actions will adhere to established protocols presented in the QAPP. Checks for analytical precision will include the analysis of matrix spike/matrix spike duplicates (MS/MSDs), laboratory duplicates and field duplicates. Checks for field measurement precision will include duplicate field measurements.

The precision of data will be measured by calculating the Relative Percent Difference (RPD) by the following equation:

$$RPD = \frac{(A-B)}{(A+B)/2} \times 100$$

Where:

A = Analytical result from one of two duplicate measurements.

B = Analytical result from the second measurement.

Accuracy

Accuracy is a measure of how close a measured result is to the true value. Both field and analytical accuracy will be monitored through initial and continuing calibration of instruments. In addition, reference standards, MSs, blank spikes and surrogate standards will be used to assess the accuracy of the analytical data.

Accuracy will be calculated in terms of percent recovery as follows:

$$\% \text{ Recovery} = \frac{A-X}{} \times 100$$

Quality Assurance Project Plan Worksheet #37 – Usability Assessment

B

Where:

A = Value measured in spiked sample or standard.

X = Value measured in original sample.

B = True value of amount added to sample or true value of standard.

Sensitivity

Sensitivity is a quantitative measurement to determine if the analytical laboratory's procedures/methodologies and their associated detection limits can satisfy the project requirements as they relate to the project action limits. DLs are updated annually by the laboratory. The current DLs for the analytical laboratories are presented in Worksheet #15.

1. Data Validation and Usability

ARCADIS will validate data generated using the United States Environmental Protection Agency's (USEPA's) National Functional Guidelines (Organics October 1999 and Inorganics October 2004), USEPA Contract Laboratory Program National Functional Guidelines for Chlorinated Dibenzo-p-Dioxins (CDDs) and Chlorinated Dibenzofurans (CDFs) Data Review, (September 2011), and USEPA Region 2 SOP HW-31, Rev. 6 Analysis of Volatile Organic Compounds in Air Contained in Canisters by Method TO-15, (June 2014) for data validation, available at the time of project initiation. These procedures and criteria may be modified, as necessary, to address project-specific and method-specific criteria. Data validation will consist of data screening, checking, reviewing, editing and interpretation to document analytical data quality and to determine whether the quality is sufficient to meet the DQOs.

The data validator will verify that reduction of laboratory measurements and laboratory reporting of analytical parameters is in accordance with the procedures specified for each analytical method and/or as specified in this QAPP. Any deviations from the analytical method or any special reporting requirements apart from those specified in this QAPP will be detailed on chain-of-custody (COC) forms.

Quality Assurance Project Plan Worksheet #37 – Usability Assessment

Upon receipt of laboratory data, the following procedures will be executed by the data validator:

- Evaluate completeness of data package.
- Verify that field COC forms were completed and that samples were handled properly.
- Verify that holding times were met for each parameter. Holding time exceedances, should they occur, will be documented. Data for all samples exceeding holding time requirements will be flagged as either estimated or rejected. The decision as to which qualifier is more appropriate will be made on a case-by-case basis.
- Verify that parameters were analyzed according to the methods specified.
- Review QA/QC data (i.e., confirm that duplicates, blanks and spikes were analyzed on the required number of samples, as specified in the method and verify that duplicate and MS recoveries are acceptable).
- Investigate anomalies identified during review. When anomalies are identified, they will be discussed with the Project Manager and/or Laboratory Manager, as appropriate.
- If data appear suspect, investigate the specific data of concern. Calculations will be traced back to raw data. If calculations do not agree, the cause will be determined and corrected.

Deficiencies discovered as a result of the data review, as well as the corrective actions implemented in response, will be documented and submitted in the form of a written report addressing the following topics, as applicable to each method:

- assessment of the data package
- description of any protocol deviations
- failures to reconcile reported and/or raw data
- assessment of any compromised data
- overall appraisal of the analytical data

Quality Assurance Project Plan Worksheet #37 – Usability Assessment

- table of site name, sample quantities, matrix and fractions analyzed

It should be noted that qualified results do not necessarily invalidate data. The goal to produce the best possible data does not necessarily mean that data must be produced without QC qualifiers. Qualified data can provide useful information.

During the review process, laboratory qualified and unqualified data are verified against the supporting documentation. Based on this evaluation, qualifier codes may be added, deleted or modified by the data reviewer. Results will be qualified with the following codes in accordance with the USEPA National Functional Guidelines:

Laboratory Data Qualifiers:

J Estimated: The compound was positively identified; however, the associated numerical value is an estimated concentration greater than the DL but less than the LOQ.

B Blank contamination: The analyte was found in an associated blank above one half the LOQ, as well as in the sample.

U Undetected: The analyte/compound was analyzed for, but not detected.

Usability Assessment Data Qualifiers:

R The data are rejected due to deficiencies in meeting QC criteria and may not be used for decision making.

J Estimated: The analyte was positively identified, the quantitation is an estimation due to discrepancies in meeting certain analyte-specific quality control criteria.

UB Blank contamination: The analyte was found in an associated blank above one half the LOQ, as well as in the sample.

UJ The analyte was not detected; however, the result is estimated due to discrepancies in meeting certain analyte-specific quality control criteria.

Two facts will be noted to all data users. First, the "R" flag means that the associated value is unusable. In other words, due to significant QC problems, the analysis is invalid and provides no information as to whether the compound is present or not. Analytes with "R" values should not

Quality Assurance Project Plan Worksheet #37 – Usability Assessment

appear on data tables because they cannot be relied upon for any reason. The second fact is that no compound concentration, even if it has passed all QC tests, is guaranteed to be accurate. Strict QC serves to increase confidence in data, but any value potentially contains error.

Resolution of any issues regarding laboratory performance or deliverables will be handled between the laboratory and the data validator. Suggestions for reanalysis may be made by the Project Chemist at this point.

Validation Reports

The data validation reports will identify all deficiencies and the potential impact on the results. The ARCADIS Project Chemist or designee will amend qualifiers generated during the validation process to the database. The validation checklists and the database will be the primary location of all applicable data qualifiers. Qualifiers will be applied to the hard copy analytical reports.

Field Data Review

Field data are generated from in-field measurement, which may include a geophysical survey, well development and groundwater sampling. The quality objective for the in-field measurement activities is to obtain accurate measurements of sample characteristics, including aqueous pH, conductivity, temperature, turbidity and dissolved oxygen, using appropriate equipment. Data are recorded in field logbooks or on field sampling sheets and calibration logs. Calibration logs will be reviewed by ARCADIS Field Managers with other field documentation to identify any potential impacts to data quality and usability. Field logbooks are reviewed as part of the QC inspections.

Reconciliation with Data Usability Requirements

Data results will be examined to determine the performance that was achieved for each data usability criterion. The performance will then be compared with the project objectives and DQOs. Deviations from objectives will be noted. Data that has been rejected will not be used. Data that has been qualified but not rejected will be considered useable (i.e., qualified as estimated) and definitive data. If there is an instance where further limitations must be placed on qualified data, the data will be additionally qualified with "X." This would indicate that the associated data is non-definitive data and should be used for screening purposes only.

Additional action may be warranted when performance does not meet performance objectives for critical data. Options for corrective action relating

Quality Assurance Project Plan Worksheet #37 – Usability Assessment

to incomplete information, questionable results or inconsistent data may include any or all of the following:

- retrieval of missing information
- request for additional explanation or clarification
- reanalysis of sample from extract (when appropriate)
- recalculation or reinterpretation of results by the laboratory

These actions may improve the data quality, reduce uncertainty and eliminate the need to qualify or reject data. If these actions do not improve the data quality to an acceptable level, the following additional actions may be taken:

- extrapolation of missing data from existing data points
- use of historical data
- evaluation of the critical/noncritical nature of the sample

If the data gap cannot be resolved by these actions, the data bias and potential for false negatives and positives can be evaluated. If the resultant uncertainty level is unacceptable, the following action must be taken:

- additional sample collection and analysis

Therefore the usability of the analytical data will be assessed based on the quality controls, field and laboratory documentation, and data comparison. The data will be analyzed in the context of the sampling location, groundwater flow patterns, geology, and previous data from the Site Characterization Summary Report. All data acquired will also be reviewed to ensure that sampling was consistent with the pre-designed sampling plan. Any deviations from the sampling plan and any anomalous data will be further examined to constrain what the usability of this data is.

Step 1	**Review the project's objectives and sampling design** The Project Manager and Project Coordinator will review the key outputs defined during systematic planning (i.e., DQOs) to make sure they are still applicable. Review the sampling design for consistency with stated objectives. This provides the context for interpreting the data in subsequent steps. - Verify that required sampling procedures were used

	- Verify that required analytical methods were used - Verify all required QC samples were collected and analyzed - Evaluate QC data
Step 2	**Review the data verification and data validation outputs** The Data Validator will evaluate the completeness of the data package, verify chain of custodies, verify sample holding times were met, verify analysis methods, review QA/QC data, and investigate anomalies. The Project Coordinator and Project Manager will summarize the data using graphs, maps, and tables, and will look for patterns, trends, and anomalies (i.e., unexpected results). Review deviations from planned activities (e.g., number and locations of samples, holding time exceedances, damaged samples, non-compliant PT sample results, and SOP deviations) and determine their impacts on the data usability. Evaluate implications of unacceptable QC sample results.
Step 3	**Document data usability and draw conclusions** Determine if the data can be used as intended, considering implications of deviations and corrective actions. Discuss data quality indicators. Assess the performance of the sampling design and identify limitations on data use. Update the conceptual site model and document conclusions. Prepare the data usability summary report which can be in the form of text and/or a table.

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